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PCB EMISSIONS FROM THE
NEW BEDFORD MUNICIPAL
SEWAGE SLUDGE INCINERATOR

Preliminary Draft Final Report



GCA CORPORATION
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Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
Research Triangle Park, NC 27711

Contract No. 68-02-3168
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EPA Project Officer
David Sanchez

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July 1984

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APPENDIX A

SAMPLING AND ANALYSIS TEST PLAN

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SAMPLING AND ANALYSIS
PROTOCOLS FOR THE MULTIPLE
HEARTH SEWAGE SLUDGE INCINERATOR
AT THE NEW BEDFORD MUNICIPAL
WASTEWATER TREATMENT PLANT

Amended Test Plan

August 1984

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SECTION 1

INTRODUCTION

The Environmental Protection Agency is currently conducting a comprehensive evaluation on the occurrences, transport mechanisms and fate of polychlorinated biphenyls (PCBs) within the New Bedford Harbor Area. Among those processes presently under investigation as a source of PCBs is the Multiple Hearth Incinerator at the New Bedford Wastewater Treatment Plant.

This treatment plant is of considerable interest since it presently processes both municipal and industrial wastewater from the city of New Bedford. It is estimated that industries contribute 60 percent of the total plant influent while municipal sources account for the remaining 40 percent. Two of the industrial facilities that feed the treatment plant are known to have used significant amounts of PCBs. While these plants no longer use PCB, quantities of this environmental contaminant still remaining in their sewer lines can potentially be flushed out of the plants and into their wastewater discharge. At the Municipal Treatment Plant, the PCBs can adhere to the solid sludge and undergo subsequent processing with the sludge. In the plant's multiple hearth incinerator this sludge is combusted and PCBs potentially released as a gaseous, or solid waste emission.

Given the relatively low operating temperature of the Multiple Hearth Incinerator and low PCB destruction efficiencies (<97%) reported for these units, serious consideration should be given to emissions of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF), and other chlorinated combustion by-products potentially formed during the incineration process. Tests conducted in 1977 at this incinerator reported measurable concentrations of PCB in the incinerator flue gas emissions and process water.¹ However, no data presently exists on PCDD and PCDF emissions from the unit. Based on limited results available on the New Bedford Municipal Incinerator, a complete sampling and analysis program has been designed to establish the fate of PCBs within the treatment plant facility.

The subsequent sections of this test plan will address the sampling and analysis protocols chosen for the New Bedford facility. This program is designed to provide a complete mass balance of all incinerator process streams for PCBs including gaseous and particulate emissions, sludge feed, hopper ash, precooler and scrubber water feeds, scrubber water effluent and centrifuge effluent.

Analysis for PCDFs and PCDDs will be conducted on gaseous and particulate emissions as well as hopper ash. Complete organic chemical analysis will be conducted on composite samples of the sludge feed. This analysis will address major components including PCBs, PCDFs, and PCDDs. In addition, grab samples of sludge feed will be collected and analyzed for total PCBs. It is anticipated that these measurements will provide necessary data on the variability of PCB content in the influent sludge.

SECTION 2

SAMPLING AND ANALYSIS

SAMPLING PROTOCOL

Flue Gas Sampling Train

The proposed approach for sampling PCBs in the incinerator flue gas will include three complete tests of the incinerator at normal operation. These tests will commence only after normal incinerator hearth temperatures have been established (i.e., temperature in hearths 3, 4 and 5 greater than 650°C [1100°F]).

A modified Method 5 train will be used for the simultaneous collection of particulates, HCl, PCBs, PCDDs and PCDFs. A schematic of the train is presented in Figure 1.

The sampling train will be operated in accordance with the procedures outlined in EPA Method 5. Accordingly, representative samples of the flue gas will be obtained from predetermined sampling points in the stack. The specifications of these points will be calculated in accordance with the guidelines set forth in EPA Method 1. The sample train will consist of a glass-lined, heat-traced probe with a stainless steel button hook nozzle. The probe is equipped with a thermocouple and pitot tubes. The flue gas will pass through the probe and then through a heated glass fiber filter (Reeve Angel 934 AH filter paper). Downstream of the heated filter, the sample gas will pass through two impingers containing distilled deionized water, an empty knockout impinger, and two organic sorbent traps containing florisil and XAD-2 resins, respectively. The temperature of the sample gas entering the sorbent traps will be maintained at less than 68°F throughout the sampling period. The sorbent traps are followed by three impingers, the first two containing 100 ml of 1N NaOH for HCl collection and the third containing dessicant. The impingers will be followed by a pump, dry gas meter and calibrated orifice.

The sampling and velocity traverse will be conducted along two perpendicular diameters of the stack. A total of 24 points will be sampled on each diameter resulting in a final total 48 sampling points. The sampling time will be 4 minutes per point for a total sampling time of 192 minutes. Figures 2 and 3 present the stack schematic and the layout of stack sampling points, respectively.

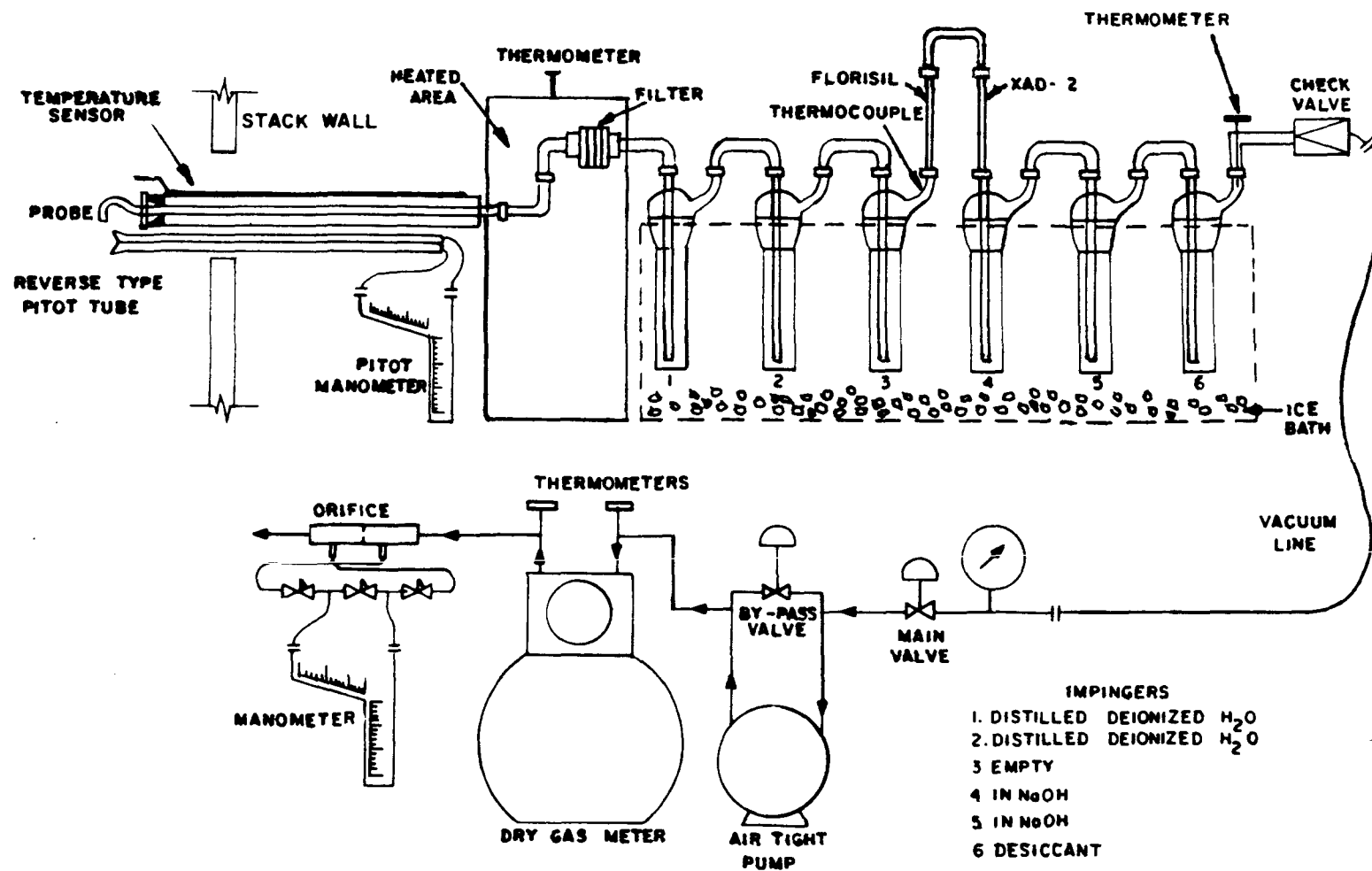
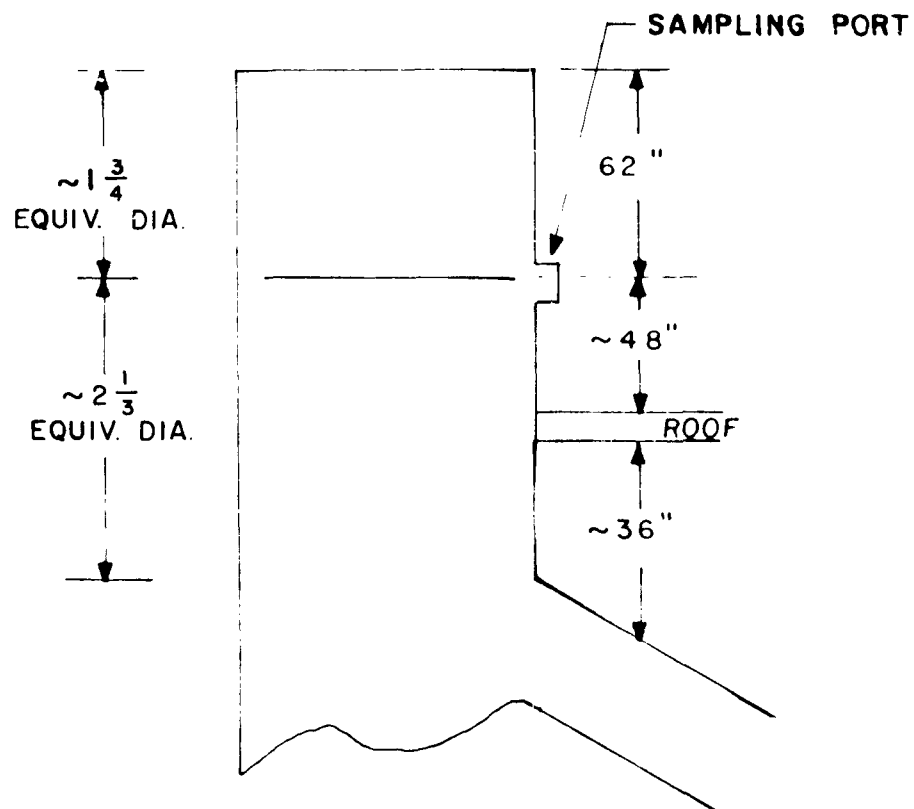


Figure 1. Flue gas sampling train.



OUTER CIRCUMFERENCE OF STACK $\approx 113.5" = \sim 3'$ I.D.

Figure 2. Schematic of stack.

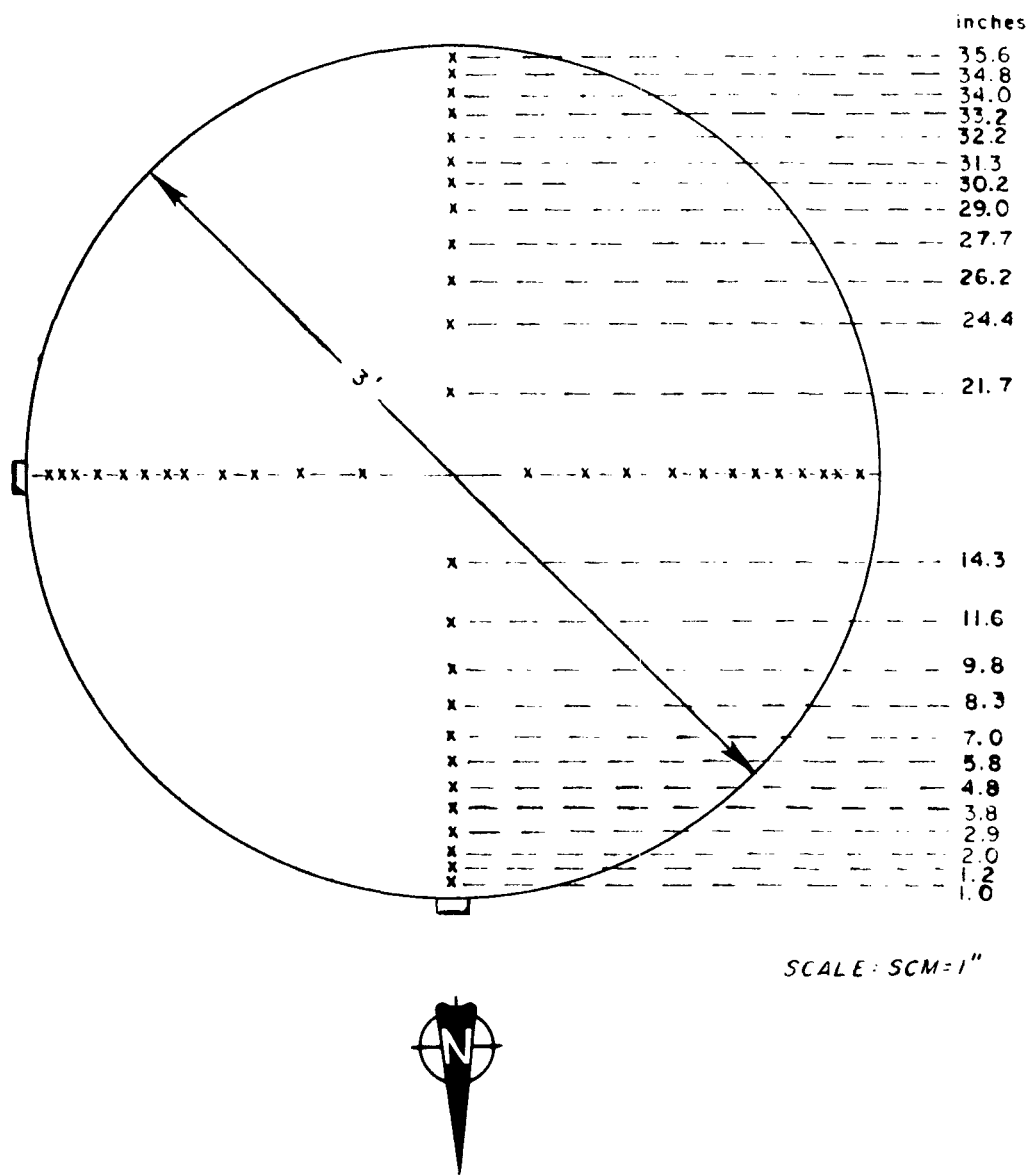


Figure 3. Stack sampling points.

The stack inner diameter will be checked prior to sampling, although it is presumed that Figures 2 and 3 adequately represent this sampling location. An additional, integrated sample of flue gas will be collected during each of the three tests for fixed gas analysis (CO_2 , O_2 , CO). All of the sampling and analysis procedures will be carried out in accordance with EPA Method 3.

Sampling will be isokinetic (± 10 percent) with readings of flue gas parameters recorded at every sampling point during the traverse. In the event that isokinetic sampling cannot be maintained, the train will be shut down and the problem remedied. In the event that steady operation is not maintained, or there are atypical fluctuations in monitored gas parameters (CO , O_2), the testing will be stopped until these conditions are stabilized. Steady operation of the incinerator will be the responsibility of Treatment Plant personnel, but the flue gas parameters and composition will be monitored by GCA. Any changes will be noted and relayed to Treatment Plant personnel so that appropriate action can be taken. Suggested parameters for monitoring by Treatment Plant personnel are listed in Table 1.

The recovery procedures for the flue gas sampling system will be:

1. Remove the sampling train to the predetermined recovery area.
2. Note the condition of the train (e.g., color of the desiccant, resin condition, etc.).
3. Remove, seal and label the florisil and XAD-2 tubes with the codes X-FL and X-XR, respectively. The run number (X) should precede all sample codes (e.g., 1-FL).
4. Brush and rinse the sampling probe liner and front half of the filter assembly with equal amounts of acetone and methylene chloride. Label the sample with the code X-FH.
5. Recover the particulate filter into its original glass petri dish and label with the code X-PF.
6. Measure the volume of the impingers 1, 2 and 3 in a precleaned graduated cylinder and transfer to an amber glass sample bottle labeled X-Cond-0.
7. Rinse the impingers 1, 2 and 3 with acetone followed by hexane into an amber glass container and measure and label X-BH.
8. Measure and recover impingers 4 and 5 into a Nalgene container and label X-IMP.
9. Record the weight gain of the desiccant contained in the final impinger.
10. Ensure that all sample containers are properly sealed, labeled and the liquid levels marked. Log all samples in sample packing list.

TABLE 1. INCINERATOR OPERATIONAL PARAMETERS TO BE MONITORED
BY PLANT PERSONNEL AT THE NEW BEDFORD MUNICIPAL
WASTEWATER TREATMENT PLANT

Incinerator temperatures	Normal range (°F)
Hearth 1	1000-1900
2	1000-1900
3	1000-1900
4	1000-1900
5	1000-1900
6	700-1000
7	200-500
Scrubber inlet temperature	120-150
Scrubber outlet temperature	40-60
Cool air exchanger temperature	250-325
Incinerator draft	0.0-0.45 in. W.G.
Scrubber Differential Pressure	2.0-5.0 in. W.G.
Natural Gas Fuel Rate	ft ³ /min ^a

^aRate will be measured daily.

EPA sampling protocol requires the use of a blank flue gas train for each day of sampling in order to provide blank corrections. This train must be set up and recovered each day of sampling.

Figure 4 is a flow diagram for the sample recovery of the flue gas train. Table 2 presents a complete listing of the samples to be taken during the entire testing program.

Continuous Monitoring

A continuous monitoring system will be used to monitor CO, CO₂ and O₂. The continuous monitoring system will be equipped with a gas conditioning system and continuous chart recorders. The flue gas will be extracted from the stack and drawn through a flue gas conditioning system to remove moisture (by condensation) and particulates (by filtration through glass fiber filter media).

Oxygen concentrations will be determined using a Horiba Model POA 21 Polarographic O₂ Analyzer with a measuring range of 0 to 20 percent O₂ full scale. The analyzer will be calibrated at 0 percent O₂ with ultrapure nitrogen and with two other appropriate span gases before and after each test.

Carbon dioxide concentrations will be determined using a Horiba Model PIR 2000 NDIR Carbon Dioxide Analyzer with a measuring range of 0 to 25 percent CO₂. This monitor will be calibrated with a zero and two span gases in an analogous fashion to the previously described O₂ monitor.

Carbon monoxide concentrations will be determined using a Horiba Model PIR 2000 NDIR CO Analyzer with a measuring range of 0-500 ppm CO full scale. This will be calibrated with a zero and two span gases in an analogous fashion to the O₂ and CO₂ analyzers.

Table 3 lists the analyzer specifications for all the above determinations.

Four strip chart recorders will be used to record all monitoring data. The data will be corrected for calibration drift, if any, and reduced to 15-minute averages. Maximum and minimum values for each test period will also be determined.

The continuous emission monitors will be calibrated twice daily from Airco cylinders containing certified (± 1 percent) calibration gases. This gas will be prepared according to EPA protocol 1.

Testing Schedule

The proposed sampling program will include three complete tests of the incinerator at normal load or steady state operation. It is anticipated that at least two complete tests can be collected during a given 24 hour period of continuous incinerator operation. The sludge will be fed to the incinerator after normal hearth temperatures have been established. The sampling will require approximately 3 hours for each test.

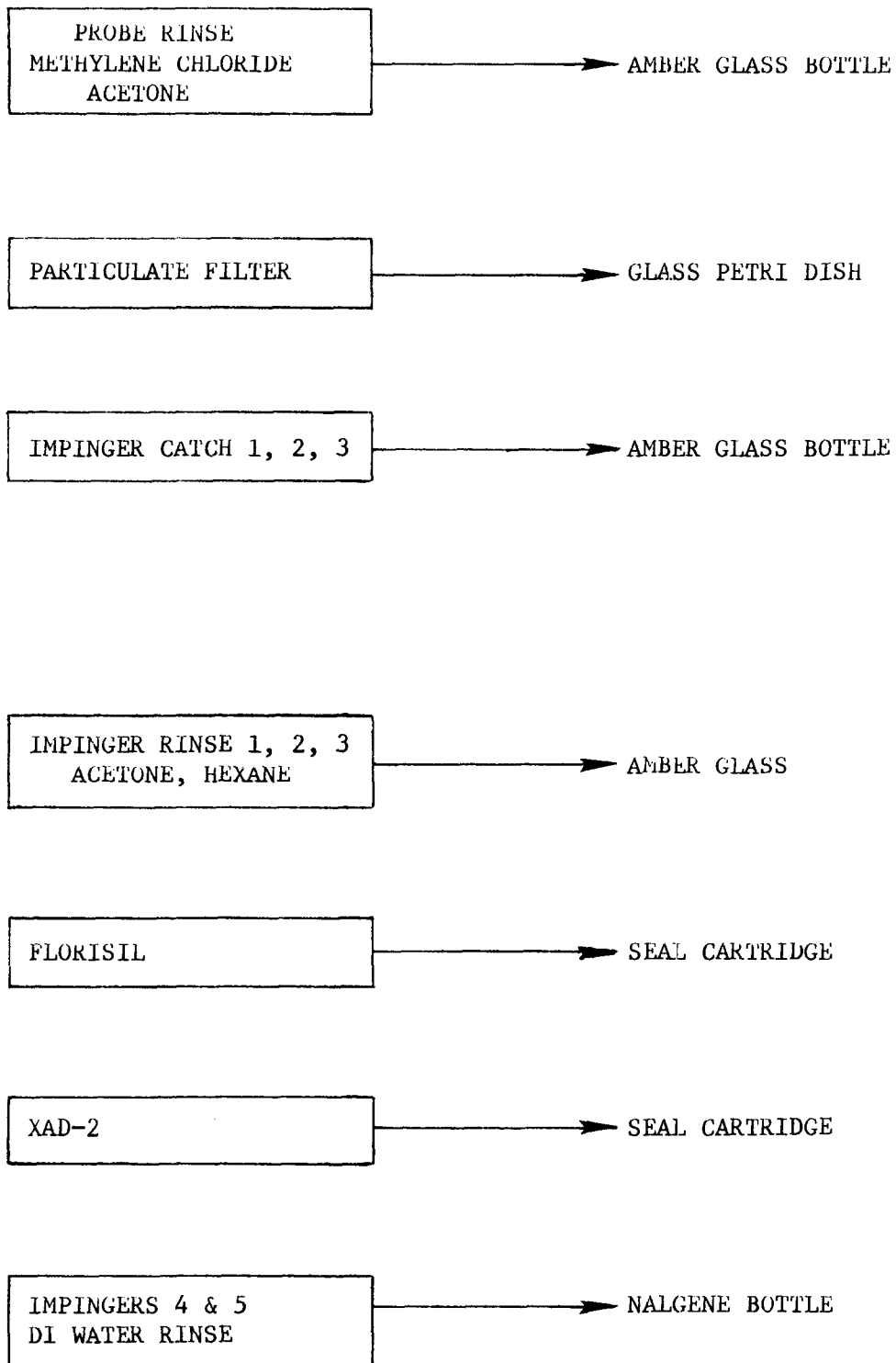


Figure 4. Flue gas train sample recovery.

TABLE 2. SAMPLES TO BE COLLECTED AT NEW BEDFORD MUNICIPAL INCINERATOR

Matrix	Sample	Source	Species to be analyzed	Number
Flue Gas	Particulate filter	Train	PCBs, PCDDs, PCDFs, Other Organics	3
Modified Method 5 train	Particulate rinses	Train	PCBs, PCDDs, PCDFs, Other Organics	3
	Florisil resin	Florisil tube	PCBs, PCDDs, PCDFs, Other Organics	3
	XAD-2 resin	XAD-2 tube	PCBs, PCDDs, PCDFs, Other Organics	3
	Impinger water	Impingers	PCBs, PCDDs, PCDFs, Other Organics	3
	Impinger catch (1N NaOH)	Impingers	Chloride	3
	Solvent rinses of train	System rinse	PCBs, PCDDs, PCDFs, Other Organics	3
Method Blanks	XAD-2 resin blank	XAD-2 lot	PCBs, PCDDs, PCDFs, Other Organics	3
(One Complete Train Per Run)	Florisil resin blank	Florisil lot	PCBs, PCDDs, PCDFs, Other Organics	3
	Filter lot blank	Filter lot	PCBs, PCDDs, PCDFs, Other Organics	3
	Hexane blank	Hexane lot	PCBs, PCDDs, PCDFs, Other Organics	3
	Acetone blank	Acetone lot	PCBs, PCDDs, PCDFs, Other Organics	3
	Impinger water blank	Organic-free laboratory water	PCBs, PCDDs, PCDFs, Other Organics	3
	1N NaOH	NaOH lot	Chloride	3
Solids	Sludge feed	Screw conveyor at incinerator inlet	PCBs	21
	Ash	Ash hopper	PCBs, PCDDs, PCDFs, Other Organics	9
Waters	Precooler/scrubber water feed	Precooler inlet	PCBs, Other Organics	9
	Scrubber water effluent	Scrubber drain	PCBs	9
	Centrifuge water	Centrifuge outlet	PCBs, Other Organics	9
	Plant influent wastewater	Head of plant	PCBs, Other Organics	9

TABLE 3. ANALYZER SPECIFICATIONS OF CONTINUOUS MONITORS

	Horiba PIR 2000 CO ₂ analyzer	Horiba PIR 2000 CO analyzer	Horiba POA 21 OPE 315 O ₂ analyzer
Operating Sensitivity Ranges	0-5% CO ₂ , FS 0-15% CO ₂ , FS 0-25% CO ₂ , FS	0-500 ppm CO, FS 0-1500 ppm CO, FS 0-2500 ppm CO, FS	0-5% O ₂ , FS 0-20% O ₂ , FS 0-50% O ₂ , FS
Operating Temperature Ranges	24°F - 122°F	24°F - 122°F	32°F - 122°F 95% Humidity
12 Analysis Method	Nondispersive Infared	Nondispersive Infared	Polarographic
Linearity	<u>+1%</u> FS	<u>+1%</u> FS	<u>+0.5%</u> of Full Scale
Accuracy	<u>+1%</u> of Full Scale	<u>+1%</u> of Full Scale	<u>+1%</u> of Full Scale
Drift	<u>+1%</u> of Full Scale in 24 hours in both zero and span	<u>+1%</u> of Full Scale in 24 hours in both zero and span	5% Full Scale for 24 hours in both zero and span
Noise level	0.5% of Full Scale in most sensitive range	0.5% of Full Scale in most sensitive range	0.25% of Full Scale in most sensitive range

Sludge

A grab sampling procedure will be used to obtain a composite sludge sample. The sludge sampling location will be at the end of the screw conveyor, as the sludge enters the incinerator. Grab samples, each 50 ml in volume, will be obtained at 30 minute intervals throughout each test run. These samples will be collected in 100 ml wide mouth amber glass jars with teflon lined caps. The 21 jars, 7 for each test run, will be clearly labeled in sequential order and then transported to the laboratory for analysis.

Ash

Ash samples will also be obtained by grab sampling. These samples will be taken from the feed line to the ash storage hopper. Sample size will be approximately 75 ml and will be collected at 60 minute intervals during each 3-hour test run. All ash samples will be transferred into 250 ml wide mouth glass bottles lined with a teflon lined cap. Each of nine samples, three for each test run, will be clearly labeled and then transported to the laboratory for analysis.

Precooler/Scrubber Water Feed

The precooler/scrubber water feed will be sampled from a tap located on the precooler inlet. Three samples will be collected during the course of each 3-hour run. It is anticipated that a total of nine such samples will be collected. All sample bottles will be clearly labeled and then transported to the laboratory for analysis.

Precooler/Scrubber Water Effluent

Samples of the precooler/scrubber water effluent will be taken at hourly intervals during each test run. Again, assuming sampling runs of three hours in duration three separate scrubber water effluent samples will be collected per test. A total of nine samples will result from the three test programs. All samples will be taken from a tap located on the scrubber drain line. All samples will be placed in wide mouth amber glass jars and transported to the laboratory for analysis.

Centrifugate Water

Aqueous samples will be collected at hourly intervals from a tap located at the base of the centrifuge. Three samples will be taken during each three hour test period. A total of nine samples will result from the three scheduled runs. All samples will be placed in wide mouth amber glass jars and transported to the laboratory for subsequent analysis.

Plant Influent Wastewater

Influent samples will be collected at hourly intervals from the head of the plant in the vicinity of the grid screen. Three grab samples will be taken during each test run. A total of nine samples will result from the test program. All samples will be placed in wide mouth amber glass jars and transported to the laboratory for subsequent analysis.

A summary of the sampling procedures for the flue gas, sludge, ash and aqueous samples is provided in Table 4.

Field Parameter Measurements

During each of the three tests, various physical parameters will be measured and monitored by the sampling contractor, including continuous monitoring of the flue gas for CO and O₂. While there are no minimum or maximum values for CO and O₂ set forth in the Federal Register for sewage sludge incinerators, as there are for Annex I incinerators and high efficiency boilers, monitoring and recording of the flue gas composition will aid the post-test review of PCB destruction efficiency. All monitors will be equipped with a gas conditioning system and each will be calibrated prior to and during use as required.

Other physical parameters will also be measured during this testing program. These parameters include the flue gas velocity, static pressure and temperature. These measurements shall be made prior to each run for the determination of proper nozzle size and sampling rate.

Since there are presently no meters in place to monitor sludge and precooler/scrubber inlet and outlet water stream flows a portable noninvasive flow monitor will be used. As there is no available location for direct on-line monitoring of sludge flow as it enters the incinerator, flow monitors will be placed at both the inlet and outlet of the centrifuge. The inlet monitor will record sludge flow and the outlet monitor will record exit meter flow. These measurements in conjunction with the density of sludge "as fired" will provide sludge flow data.

The solids and PCB content of the sludge "as fired" will be determined, and these measurements will later be used to calculate the dry sludge feed rate and PCB input rate to the incinerator for each test.

Sludge flow rate measurements will also be provided by a supplementary technique involving reversing the screw conveyor and weighing the sludge caught in a plastic bag during a specific time interval. This will be done immediately before and after each test run. In addition, if the flue gas sampling is halted during a sampling run for any reason, the sludge feed may be measured during this interruption. The results of these measurements will be used to verify on an instantaneous basis the calibration of the portable flow meter.

Immediately before the start of each test run the ash collection hopper will be emptied. This action can be coordinated with treatment plant personnel. At the conclusion of each run, the volume of ash in the hopper will be measured. Laboratory analysis of the ash samples will yield the bulk density of the ash (in pounds per cubic foot) and organic analysis as noted earlier. These factors will allow the calculation of the ash production rate (in pounds per minute, hour, etc.) and emission rates for PCBs and combustion by-products such as PCDFs and PCDDs potentially formed during the incineration process.

TABLE 4. TEST RUN SAMPLING PROCEDURES AT NEW BEDFORD SEWAGE SLUDGE INCINERATOR

Stream A - Input sludge

Sampling location: Immediately after the end of the screw conveyor as the sludge enters the incinerator.

Number of samples per run: Seven grab samples of approximately 50 ml each, collected in individual 100 ml wide mouth jars with Teflon lined caps, will be collected at 30-minute intervals, beginning with the start of each test.

Stream B - Ash

Sampling location: Feed to the ash storage hopper.

Number of samples per run: Three grab samples of approximately 75 ml each, transferred and composited in a 250 ml wide mouth glass bottle with Teflon lined cap, will be collected at 60 minute intervals, beginning with the start of each test.

Stream C - Precooler and scrubber water feeds

Sampling location: Tap located on precooler feed line.

Number of samples per run: Three samples of approximately 250 ml each, transferred and composited in a 1250 ml wide mouth amber glass bottle with Teflon lined cap, will be collected at 60 minute intervals in duplicate, beginning with the start of each test.

Stream D - Scrubber water effluent

Sampling location: Tap located on scrubber drain line.

Number of samples per run: Three samples at approximately 500 ml each, transferred and composited in a 3000 ml wide mouth amber glass bottle with Teflon lined cap, will be collected at 60 minute intervals in duplicate, beginning with the start of each test.

(continued)

TABLE 4 (continued)

Stream E - Stack gas

Sampling location: Existing ports on 3' diameter stack.

Number of sample
points: A total of 48 points, 24 along each diameter
of the stack.

Sampling Requirements

The stack sampling program will require 4 days of testing. A total of three tests of at least 3 hours each will be conducted over a two day period assuming 24 hour periods of continuous unit operation. The incinerator operation will be at steady state for the tests.

Incinerator operation including sludge feed and incinerator conditions such as hearth temperatures and precooler/scrubber water feed will be the responsibility of New Bedford wastewater treatment plant personnel. All data gathered will be made available to the testing contractor for assessment purposes.

Other requirements to be provided by plant personnel include the following:

- Adequate electrical power for both stack sampling trains.
- Laboratory area in an accessible location for sample recovery.
- Parking for truck nearby stack location.

All samples collected will be inventoried in the field. Chain of custody will be maintained through the use of log books. Upon receipt at the GCA laboratory, the samples will be checked against the inventory sheets and assigned laboratory log numbers. All sample handling will be controlled to prevent loss or alteration of samples. All data sheets will be bound and filed.

ANALYTICAL PROTOCOLS

Introduction

As noted earlier in Table 2, analyses will be conducted on sample sets collected during each of three test runs at the New Bedford facility. Each of three complete sets of flue gas samples and associated field blanks will be analyzed for polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs) polychlorinated dibenzofurans (PCDFs) and other organic components. In addition, approximately 21 sludge feed samples will be analyzed for PCBs; hopper ash grab samples from each test run will be analyzed for PCBs, PCDDs, PCDFs and other organic components; precooler/scrubber water feed samples from each test run will be analyzed for PCBs and other organics; scrubber water effluent samples from each test series will be analyzed for PCBs; centrifugate water and plant influent wastewater samples collected during each test run will also be analyzed for PCBs and other organics. The description that follows will provide further details on the analyses of each of these matrices.

Flue Gas Samples--Gas Phase

The Gas Phase is defined as all train samples except the particulate filter and probe rinse which are addressed in the next section. Each of the three sets of steady state runs and corresponding field and method blanks will be analyzed for the following parameters:

- PCBs as positional isomer classes in both the particulate and gaseous phases.
- PCDDs/PCDFs - again as positional isomer classes in both the particulate and gaseous phases.
- Other Organics - Results for other major organic components in each of the particulate and gaseous phases and not members of the above organic classes.
- Chloride - in the NaOH impingers only.

Each flue gas sample set contains the following sample types:

- Back half rinse (acetone/hexane)
- Organic condensate and Aqueous impingers (DI H₂O)
- Florisil sorbent
- XAD-2 sorbent
- Aqueous impingers (NaOH)

There are also corresponding field blanks associated with each of the above sample types. There is one complete field-biased blank set for each of the respective test days.

A summary of the organic analysis scheme appropriate for the flue gas samples (gas phase) is provided in Figure 5. Pertinent instructions on the preparation and analysis of each sample type is provided below.

Back-Half Rinses (Acetone/Hexane)--

Hold for combination with aqueous extracts. Combined extracts will be concentrated to a final volume using Kuderna-Danish evaporative concentrator.

Organic Condensate/Impingers (DI H₂O)--

Should be combined prior to extraction. Sequential extractions should be performed using methylene chloride (3x). Extracts should be held for eventual combination with the train rinses and sorbent extracts.

Impingers (NaOH)--

Analyze for chloride content.

GC/MS Analyses (PCBs, PCDFs, PCDDs, Other Organics)--

Analyses for PCBs as positional isomer categories will be conducted using a Hewlett-Packard 5985 GC/MS operating in the total ion mode. A summary of GC/MS operating conditions suggested for these analyses is provided in Table 5. Instrument calibration should be established using at least one isomer from each of ten PCB positional isomer categories. Use of the following representative isomers as well as the parent biphenyl is suggested:

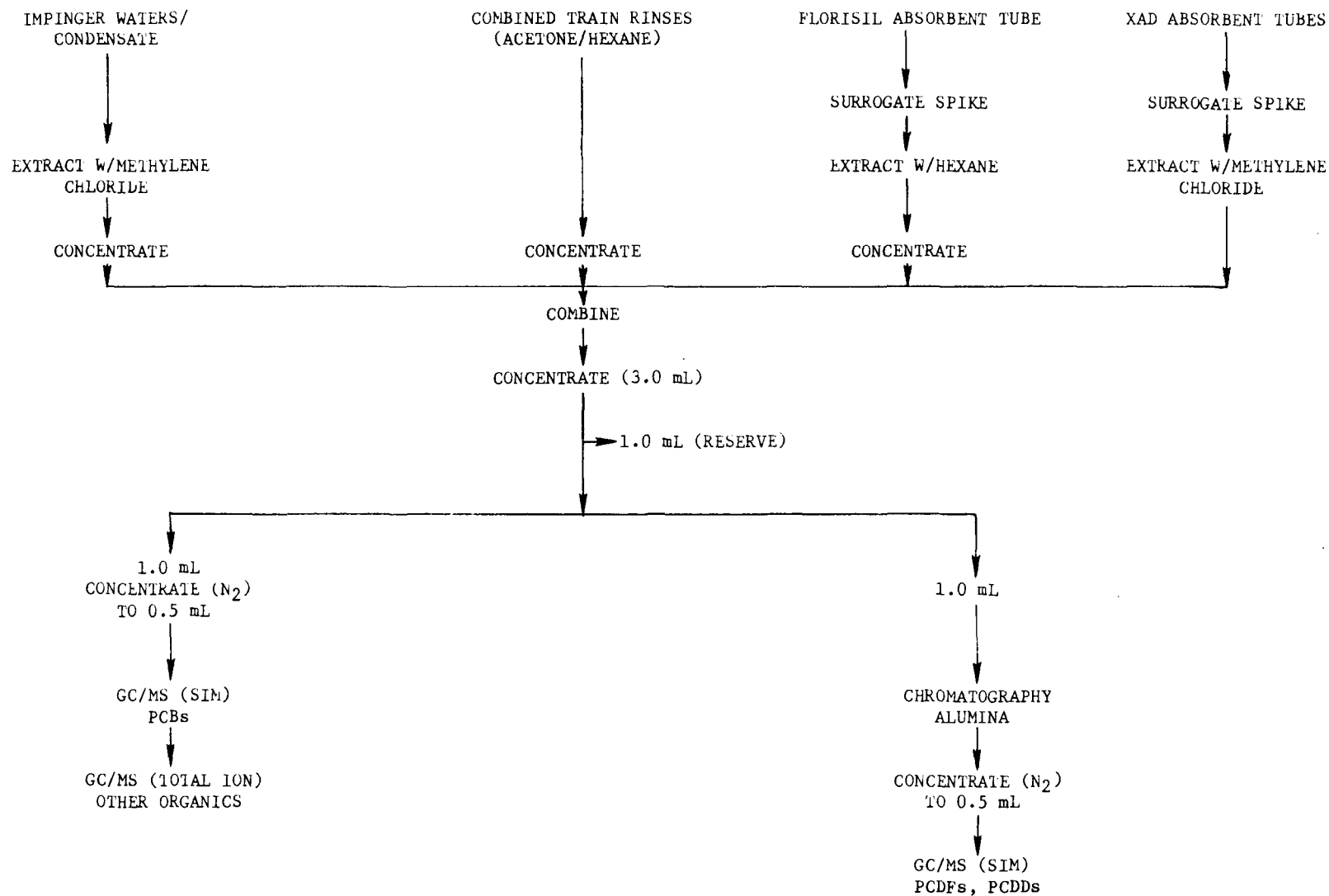


Figure 5. Organic analysis flow scheme--gas phase flue gas samples.

TABLE 5. GC/MS OPERATING CONDITIONS

Instrument	Hewlett Packard 5985, quadrupole mass spectrometer
GC Conditions	
Column	DB-5 30M fused silica capillary (or equivalent)
Temperature program	50°C held for 2 min then 10°/min to 300°C and held
Injector type	Grob w/0.5 min sweep time
Injector temperature	275°C
Injection volume	1 µl, splitless
Column flow	UHP helium, 0.5 ml/min
MS Conditions	
Emission	300 µA
Electron energy	70 eV
Scan time	1.0 s/scan
Mass interval	45 to 450 amu
Source temperature	200°C

- 2-Chlorobiphenyl
- 4-Chlorobiphenyl
- 3,3'-Dichlorobiphenyl
- 2,5-Dichlorobiphenyl
- 2,3,5-Trichlorobiphenyl
- 2,4,5-Trichlorobiphenyl
- 2,3,4,5-Tetrachlorobiphenyl
- 2,2',4,4',5-Pentachlorobiphenyl
- 2,2',4,4',6,6'-Hexachlorobiphenyl
- 2,2',3,4,5,6,6'-Heptachlorobiphenyl
- 2,2',3,3',4,4',5,5'-Octachlorobiphenyl
- 2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl
- 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl

Analyses for PCDDs/PCDFs as positional isomer categories will also be conducted using the Hewlett-Packard 5985 GC/MS. Instrument conditions will be identical to those cited in Table 5, with the exceptions that spectra will be acquired in the selected ion mode (SIM). Instrument calibration will be provided for a variety of chlorinated dioxins and chlorinated dibenzofurans. A suggested listing of representative isomers for the GC/MS screening protocols are shown below.

- Dibenzofuran
- 2,8-Dichlorodibenzofuran
- Dibenzo-p-dioxin
- 1-Chlorodibenzo-p-dioxin
- 2-Chlorodibenzo-p-dioxin
- 2,6-Dichlorodibenzo-p-dioxin
- 1,2,4-Trichlorodibenzo-p-dioxin
- 1,2,3,4-Tetrachlorodibenzo-p-dioxin

The identification and quantitation of additional organic components not classified as PCBs, PCDDs or PCDFs will follow the criteria noted below.

A background-corrected spectrum of the component will first be obtained by computer subtraction. A probability-based library search (PBS) will then be conducted by computer routine, comparing the unknown spectra with those of the EPA/NIH libraries. The computer search will provide up to 10 possible matches. The spectra of library matches will then be compared directly to the unknown spectrum by the operator. For positive identification, the following conditions are required:

- The intensity, relative to the base peak, of all major peaks (greater than 50 percent of base peak) must agree within 20 percent.
- All peaks present in the library spectrum at more than 20 percent of the base peak must be present in the unknown spectrum.
- The unknown spectrum must not have any peaks present at more than 30 percent of the base peak that are not seen in the library spectrum or are not clearly attributable to coeluting compounds.

If the library search does not provide a positive match, the unknown spectra will be reviewed for major peaks and fragmentation patterns. Component concentrations will be calculated relative to the closest eluting internal standard.

Flue Gas Samples--Particulate Phase

The combined probe rinse and particulate filter samples from each flue gas train will constitute the stack particulate samples. Analyses of these samples will proceed in the following manner: particulate weights and probe rinse residue weights will be recorded. The filter and probe rinse solids will be combined prior to extraction. Extracts will be performed in an "F" soxhlet using methylene chloride. Prior to extraction each thimble will be spiked with the following surrogate mixture: d₃-trichlorobenzene, d₁₀-biphenyl, d₁₂-chrysene and decafluorobiphenyl. Spiking levels of 20-50 µg are recommended. Extracts will be reduced to a final volume using a Kuderna-Danish evaporator. GC/MS analyses for PCBs, PCDDs, PCDFs and other organic components will be conducted using the instrumental operating parameters previously cited for gas phase extracts. A schematic of the analytical flow scheme pertinent to the flue gas particulate samples is provided in Figure 6.

Hopper Ash Samples

Three grab samples will be taken from the hopper during each test run. As noted earlier they will be taken at approximately 1 hour intervals during each test run.

Thirty-five gram (35 g) aliquots will be taken from each of the three grab samples and composited resulting in a 105 g composite sample for each test series. Each composite sample will be transferred to an "F" size soxhlet thimble and fortified with a surrogate cocktail containing the following components: d₃-trichlorobenzene, d₁₀-biphenyl, d₁₂-chrysene and decafluorobiphenyl (DFB). Samples will be extracted overnight with methylene

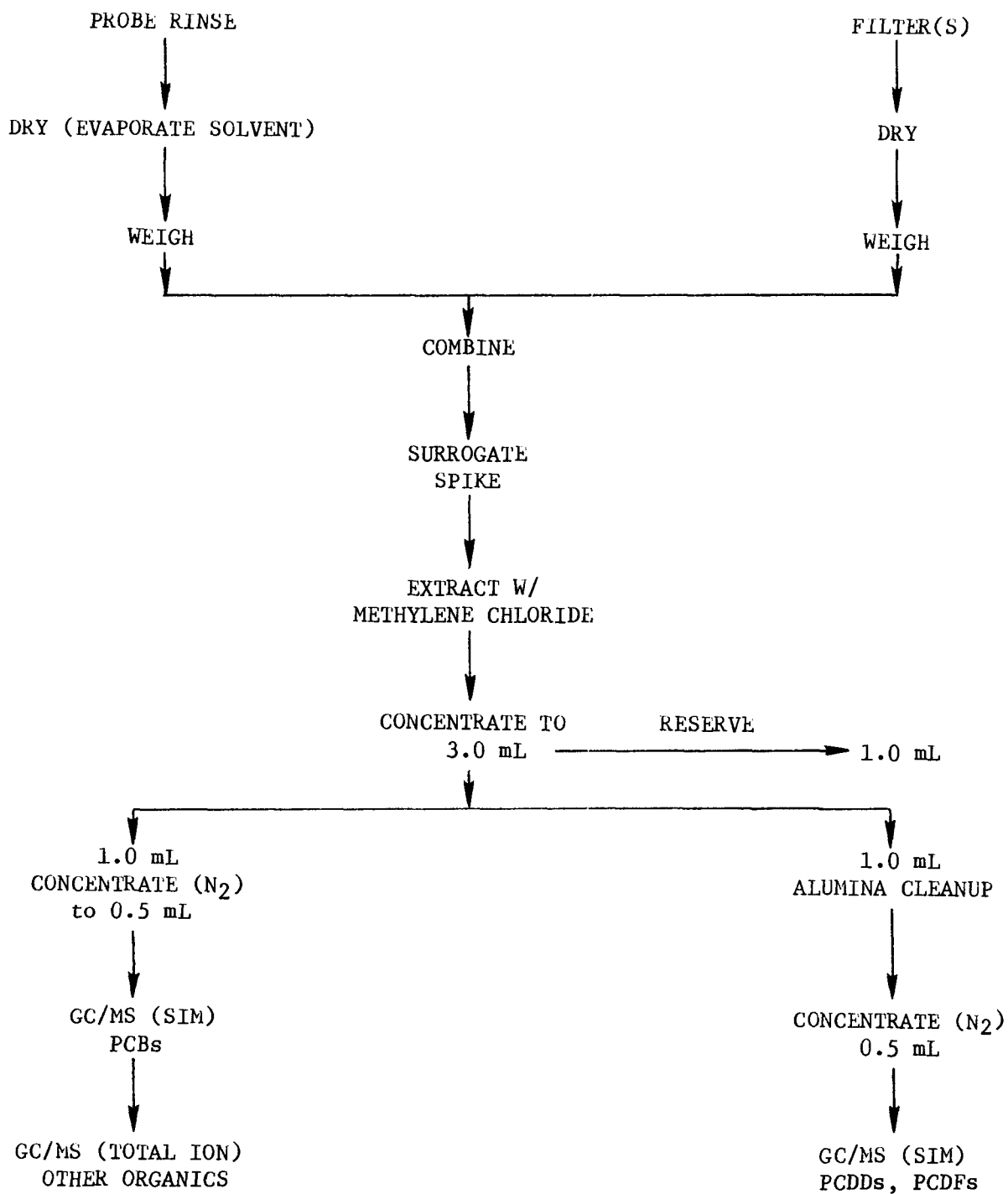


Figure 6. Organic analysis flow scheme--particulate phase flue gas samples.

chloride. Extracts will be reduced in volume to 10.0 ml using a Kuderna-Danish evaporative concentrator. A 3.0 ml aliquot will be held in reserve. A 3.0 ml portion will be further reduced to 0.5 ml, or the minimum attainable volume, for GC/MS analysis in the selected ion mode (SIM) for isomers of PCBs. GC/MS analyses for additional organics, not members of the above chemical classes, will be conducted in the total ion mode. Alumina cleanup procedures will be implemented on an additional 3.0 ml aliquot to permit unambiguous identification of PCDD and PCDF isomer classes.

Sludge Feed Samples

Grab samples of sludge feed will be taken at 1/2 hour intervals during each of the test series resulting in a total of seven samples per 3 hour period. Analyses will be conducted on each of these samples. A 10 g aliquot will be removed from each sample and air-dried. Each of these samples, in turn, will be extracted overnight in a soxhlet-extractor using a hexane/acetone (1/1) solvent system. Each resultant extract will be reduced to 5.0 ml using a Kuderna-Danish apparatus. An aliquot of each extract will be submitted for PCB analysis using a gas chromatograph fitted with an electron capture detector (GC/ECD). Samples displaying a complex or indistinguishable pattern will be subjected to additional cleanup procedures including acid (H₂SO₄) partitioning or florisil column chromatography. Webb-McCall procedures will further be used on samples not displaying a complete Aroclor pattern after these cleanup procedures.

In addition to PCB analysis via GC/ECD on each grab sample, PCB analyses as positional isomer categories will be conducted via GC/MS on composite samples from each test series. In this instance a 1.0 ml aliquot will be removed from each of the seven uncleaned sample extracts representing each test run. The composite extract will be fortified with the same surrogate cocktail used for the flue gas and hopper ash samples. Spiking levels of 5-10 µg for each of these components are recommended. Each combined extract will be further reduced in volume under a gentle stream of prepurified N₂ to the minimum volume attainable, ideally 100 µl.

Aqueous Samples

GC ECD--

Analyses will be conducted on the following types of water samples collected during each test series.

- Precooler/Scubber Water Feed--3 grab samples per run. These will be composited so as to create a single representative sample per run (e.g., one liter total).
- Scrubber Water Effluent--3 grab samples per run. These will be composited into a single representative sample per run (e.g., one liter).
- Centrifuge Water--3 grab samples per run. These will be composited into a single sample per run.

- Plant Influent Wastewater--3 grab samples per run. Each of these samples will be prepared and analyzed separately.

One liter aliquots of each of the above sample types will be extracted in a separator funnel with methylene chloride as recommended in EPA Method 608. Each extract will be dried using a sodium sulfate column and reduced in volume to 10.0 ml using a Kuderna-Danish apparatus. A 5.0 ml aliquot of each sample will be removed for PCB analysis (pattern matching) employing a gas chromatograph in combination with an electron capture detector. Florisil column chromatography and acid partitioning (H_2SO_4) procedures will be employed as needed to facilitate identification and quantitation of aroclor (PCB) mixtures.

GC/MS--

Each of the five aqueous sample streams from each test series will be analyzed further using gas chromatography/mass spectrometry. Details on additional sample preparation procedures are provided below.

Scrubber Effluent--A 5.0 ml aliquot from each 10.0 ml extract will be reduced under a stream of prepurified N_2 to 100 μ l GC/MS analyses will be conducted for each of ten PCB positional isomer categories.

Plant Influent Wastewater--A single composite sample will be prepared from the three grab samples taken during each run. A one liter composite sample representing each test series will be fortified with a surrogate mixture and extracted (3X) with methylene chloride per EPA Method 625. Each of the acid and base-neutral fractions will be reduced in volume to 1.0 ml in a Kuderna-Danish apparatus. Analysis by GC/MS will be performed for each of the EPA Method 625 analytes. Additional major organic components in the extract will be identified and quantitated as described previously using EPA/NIH libraries.

Scrubber Water/Precooler Feed and Centrifuge Water--Samples from the above categories that contained elevated levels of PCBs (GC/ECD) will be further analyzed using GC/MS to include qualitative analysis for PCBs (presence or absence confirmation). For this analysis 1/2 (e.g., 5.0 ml) of the existing extract will be reduced in volume using N_2 to 100 μ l for PCB confirmation in the total ion mode. In addition each of these extracts will simultaneously undergo GC/MS analyses for the identification and quantitation of major organic components with particular emphasis on chlorinated organics (e.g., chlorinated pesticides, chlorinated benzenes, chlorinated naphthalenes (PCNs)).

GC/ECD Analysis--PCBs--

PCB analyses of all previously designated sample extracts will be conducted using a Hewlett-Packard 5840 gas chromatograph fitted with a Ni^{63} electron capture detector. This includes each of the aqueous sample types discussed previously, as well as the sewage sludge feed grab samples collected during each test series. A summary of pertinent GC/ECD operating conditions is provided in Table 6. Instrument calibration will be provided using Aroclor 1242 and Aroclor 1254 reference materials, since these were the

TABLE 6. GC/ECD CONDITIONS FOR PCB ANALYSIS

Instrument	Hewlett-Packard 5840A with Ni ⁶³ electron capture detector and HP 7671A automatic sampler
Column	1.5% OV-17/1.95% QF-1 on 100/120 Chromosorb WHP, 6 ft x 2 mm
Temperatures	
Column	185°C
Injector	270°C
Detector	350°C
Injector volume	4.0 µl
Run time	30 min
Carrier flow	UHP argon/methane, 35 ml/min

predominant Aroclors noted in the 1977 test series. EPA/EMSL check samples will be analyzed to verify instrument calibration for each of these Aroclor mixtures. Pattern recognition procedures will be used for quantitation of each of the two Aroclor mixtures (peak summations). Webb-McCall quantitative procedures will be used in instances where chromatographic profiles do not coincide with those of the Aroclor reference materials.

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APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

EPA CONTRACT NO. 68-02-3168
TECHNICAL SERVICE AREA 3
WORK ASSIGNMENT NOS. 58, 79 AND 99
(GCA 1-619-058, 1-619-079 and 1-619-099)

REVISED
QUALITY ASSURANCE PROJECT PLAN FOR
SAMPLING AND ANALYSIS ACTIVITIES
FOR THE MULTIPLE HEARTH SEWAGE SLUDGE
INCINERATOR AT THE NEW BEDFORD
MUNICIPAL WASTEWATER TREATMENT PLANT

GCA CORPORATION
GCA/TECHNOLOGY DIVISION
Bedford, Massachusetts 01730

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1.0 PROJECT DESCRIPTION

The objective of this program is to quantify the atmospheric emissions of polychlorinated biphenyls (PCBs) from the New Bedford Wastewater Treatment Plant Multiple Hearth Incinerator. GCA will also attempt to establish the fate of PCBs within the treatment plant facility by the collection and analysis of samples from applicable process streams. Included in this evaluation is the determination of levels of PCBs, PCDD, PCDF and other chlorinated combustion byproducts. The work to be performed has been broken down into the four tasks listed below.

- Task 1 - Develop Test Plan and QA Plan--These plans will describe the test site, streams to be sampled, sampling and analysis procedures, project organization and QA/QC measures to be implemented, thus providing a concise overview of the entire program. These plans will be implemented after approval by the EPA Project Officer.
- Task 2 - Conduct Field Sampling Program--Samples will be collected as described in the Test Plan and Section 4.0 of this Plan. The primary objective of this portion of the program is to provide the representative samples necessary for determination of the fate of PCBs in this incinerator.
- Task 3 - Conduct Laboratory Analyses--A variety of analyses will be conducted on program samples. The analytical techniques are discussed in detail in the Test Plan and addressed in Section 7.0 of this QA Plan.
- Task 4 - Prepare Final Report--The results of this program will be presented in a comprehensive, final report.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 2-1 presents GCA's organization chart for this project showing the individuals responsible for each element of the overall task. The key individual responsible for QA is the Division QA Manager who reports directly to the Division General Manager. The department QC Coordinators report directly to their Department Manager and the QA Manager, enabling them to implement QC measures on all projects independent of the project manager. The responsibilities of these individuals on this project are briefly described below.

2.1 QA MANAGER'S RESPONSIBILITIES

The Division QA Manager is the responsible Quality Assurance Officer for this project. She has aided in the development of the QA Project Plan and reviewed and approved the plan before its submittal to the Project Officer. She will ensure that any necessary revisions are made and she will check on implementation of the QA Plan during the life of the project, scheduling performance or system audits as necessary.

She will initiate or follow-up on corrective actions and aid in preparation of a section of the Final Report summarizing QA/QC activities and including estimates of the precision, accuracy and completeness of data achieved. Quality problems found and corrective actions taken will be described.

2.2 FIELD AND LABORATORY QC COORDINATOR'S RESPONSIBILITIES

The Environmental Measurements Department (Field) and the Laboratory Analysis Department QC Coordinators oversee and implement the ongoing QC program within their departments. They have aided in the preparation of this QA Plan and will ensure that the required QC procedures are followed. They will initiate corrective actions as necessary, and maintain and report the QC records and results for this project.

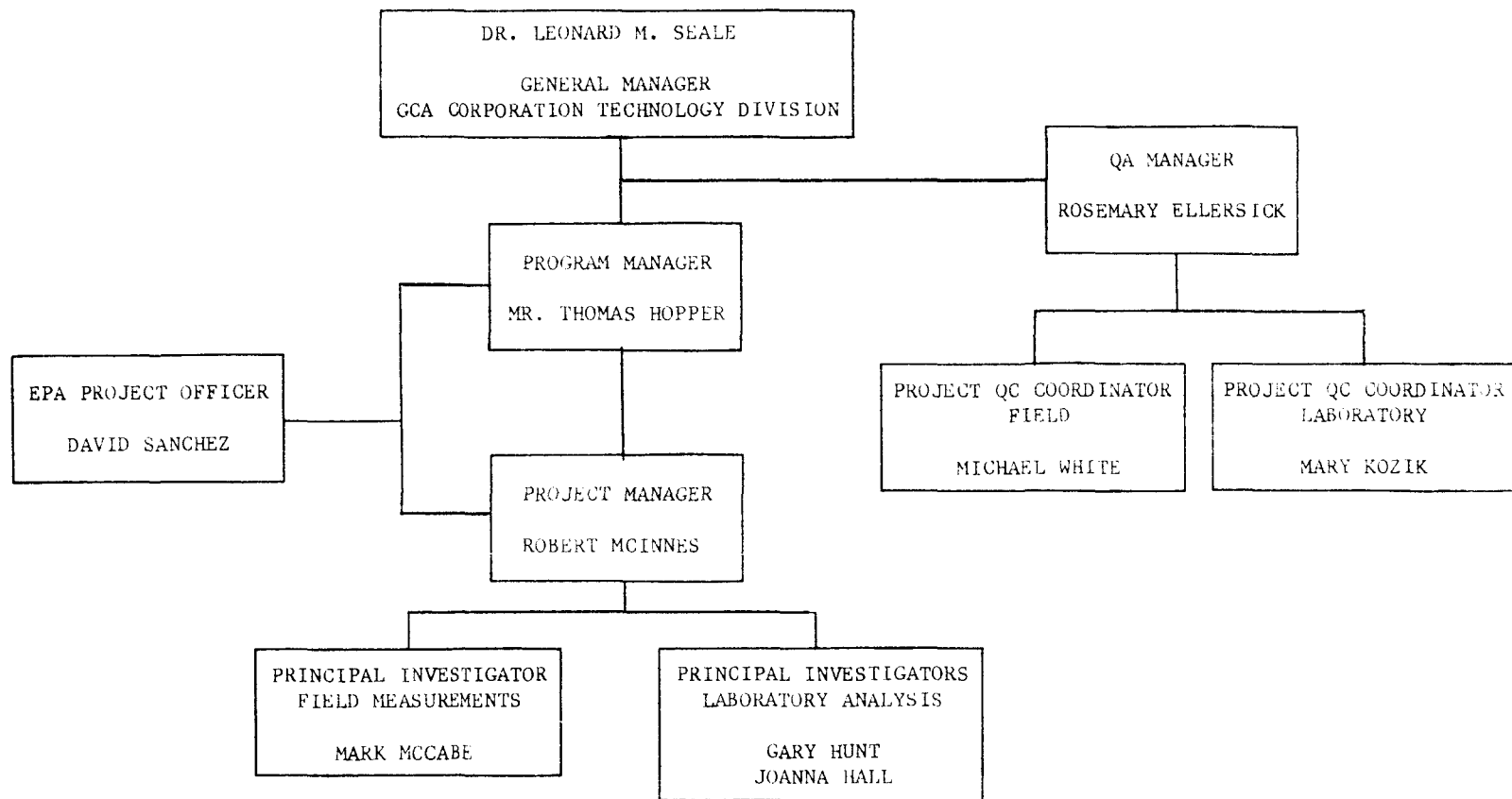


Figure 2-1. Project organization and responsibility.

3.0 QA OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

3.1 PRECISION, ACCURACY AND COMPLETENESS

The collection of data which can be used in mass balance calculations to determine the fate of PCBs during the incineration process requires that sampling and analysis procedures be conducted with properly operated and calibrated equipment by trained personnel. Precision and accuracy goals for sampling procedures are shown in Table 3-1; Table 3-2 presents the precision and accuracy goals for the analytical procedures.

Every attempt will be made to have all data generated be valid data. However, realistically, some samples may be lost in laboratory accidents and some results may be deemed questionable based on internal QC procedures. The objective will be to have 95 percent of the data valid.

3.2 REPRESENTATIVENESS AND COMPARABILITY

It is recognized that the usefulness of the data is also contingent upon meeting the criteria for representativeness and comparability. Wherever possible, reference methods and standard sampling procedures will be used. The QA objective is that all measurements be representative of the media and operation being evaluated. The detailed requirements for gaseous and particulate sampling given in Reference Methods 1-5, and the continuous monitoring requirements given in Performance Specification Tests 3 and 4 will be followed to ensure representative sampling of flue gases. The frequent grab sampling of sludge, ash and process water during each flue gas test run should provide representative samples of these media, comparable to the flue gas samples.

The corresponding QA objective is that all data resulting from sampling and analysis be comparable with other representative measurements made by GCA or another organization on this or a similar incinerator operating under similar conditions. The use of published sampling and analytical methods and standard reporting units will aid in ensuring the comparability of the data.

TABLE 3-1. QA OBJECTIVES FOR PRECISION, ACCURACY AND COMPLETENESS--
FIELD SAMPLING

Measurement (parameter)	Precision (standard deviation)	Accuracy (relative accuracy)	Completeness
Particulate Matter (EPA Reference Method 5)	12% RSD	Not determined	95%
Sorbent Trap-Florisil, XAD (Flue Gas - Train)	$\pm 50\%$	$\pm 50\%$	95%
Fixed Gases (CO, O ₂ , CO ₂) (Continuous Monitor)	$\leq 2.5\%$	$\pm 10\%$	95%

RSD = Relative standard deviation.

TABLE 3-2. QA OBJECTIVES FOR PRECISION, ACCURACY AND COMPLETENESS--
LABORATORY ANALYSIS

Measurement method	Matrix	Precision (relative standard deviation)	Accuracy	Completeness
GC-ECD	Flue gas	$\leq 20\%$	$\pm 20\%$	95%
	Sludge	$\leq 20\%$	$\pm 20\%$	95%
	Ash	$\leq 20\%$	$\pm 20\%$	95%
	Water	$\leq 20\%$	$\pm 20\%$	95%
GC/MS	Flue gas	$\leq 30\%$	$\pm 30\%$	95%
	Sludge	$\leq 30\%$	$\pm 30\%$	95%
	Ash	$\leq 30\%$	$\pm 30\%$	95%

4.0 SAMPLING PROCEDURES

4.1 FLUE GAS SAMPLING PROCEDURES

The sampling procedures for semivolatile organics (PCBs, PCDDs, PCDFs) in the incinerator flue gas will include three complete tests of the incinerator in normal operation. Each of these tests will be conducted under normal operating conditions.

4.1.1 Flue Gas Sampling Train

A modified Method 5 train will be used for the simultaneous collection of particulates, HCl, PCBs, PCDDs, and PCDFs. A schematic of the train is presented in Figure 4-1.

The sampling train will be operated in accordance with the procedure outlined in EPA Method 5. Accordingly, representative samples of the flue gas will be obtained from predetermined sampling points in the stack. The specifications of these points will be calculated in accordance with the guidelines set forth in EPA Method 1. The sample train will consist of a glass-lined, heat-traced probe with a stainless steel button hook nozzle. The probe is equipped with a thermocouple and pitot tubes. The flue gas will pass through the probe and then through a heated glass fiber filter (Reeve Angel 934 AH filter paper). Downstream of the heated filter, the sample gas will pass through two impingers containing distilled deionized water, an empty knockout impinger, and two organic sorbent traps containing florisol and XAD-2 resins, respectively. The temperature of the sample gas entering the sorbent traps will be maintained at less than 68°F throughout the sampling period. The sorbent traps are followed by a series of three impingers. The first and second impingers will contain 100 ml of 1N NaOH for HCl collection. The third impinger will contain a known amount of dessicant for moisture removal. The impingers will be followed by a pump, dry gas meter and calibrated orifice.

The sampling and velocity traverses will be conducted along two perpendicular diameters of the stack. A total of 24 points will be sampled on

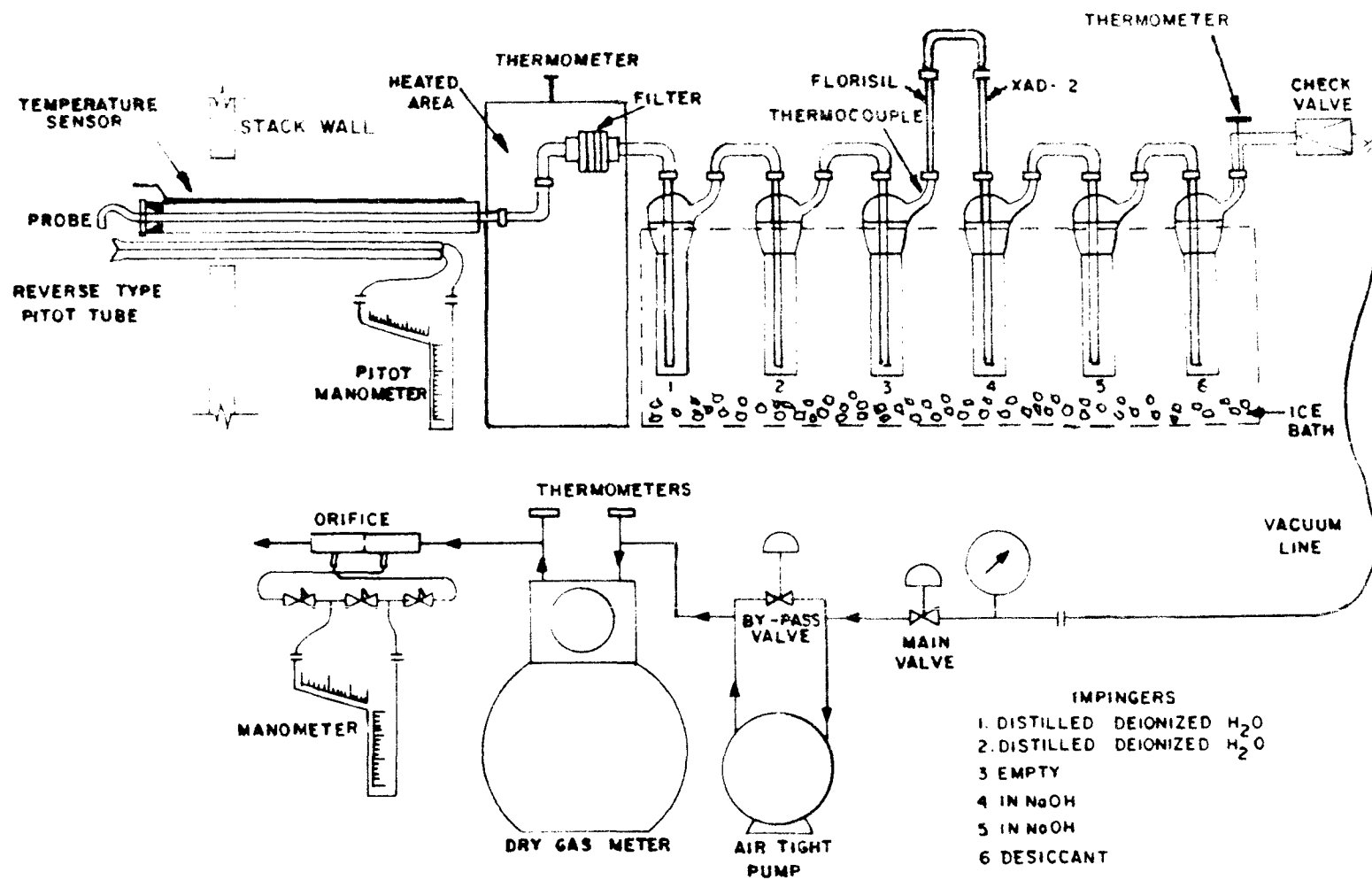


Figure 4-1. Modified Method 5 train.

each diameter, resulting in a final total of 48 sampling points. The sampling time will be 4 minutes per point for a total sampling time of 192 minutes per run.

As required by EPA sampling protocol, a blank train will be set up and recovered with the flue gas sampling train each day in order to provide appropriate blank corrections.

The recovery procedures for the sampling system will be:

1. Remove the sampling train to the predetermined recovery area.
2. Note the condition of the trains (e.g., improper color, florasil/XAD-2 condition, etc.).
3. Remove and seal the florasil and XAD-2 tubes. These tubes should be properly marked as X-FL and X-XR, respectively. The run number (X) should precede all sample codes (e.g., 1-FL).
4. Measure the volume of the impinger catches (impingers 1, 2 and 3) in a precleaned glass graduated cylinder. Pour the impinger contents into a precleaned amber glass container with a Teflon cap. Label the sample X-COND-O.
5. Rinse the impingers, probe and nozzle thoroughly with acetone followed by hexane. This rinse volume should be put into a precleaned amber glass container with a Teflon cap. Label the sample X-PR.
6. Measure the volume of impingers 4 and 5 and pour contents into a nalgene container. Label the sample as X/MP.
7. Record the weight gained by the silica gel impinger.
8. Be sure that all containers are properly sealed, labeled, and the liquid level marked. Log all samples on sample packing list.

4.1.2 Continuous Monitoring System

A portable continuous emissions monitoring system (CEMS) will be used to document combustion conditions. The monitoring system consists of a gas conditioning system and sensors for CO, CO₂ and O₂.

A schematic diagram of the CEMS is shown in Figure 4-2. Briefly, the sample is extracted from the flue stream at a point of average concentration and passed through a glass fiber filter for particulate removal. The gas exiting the filter element is then dried by passing it through a condenser for primary moisture removal. Gas analysis is performed using the instruments and operating ranges specified in Table 4-1.

Continuous monitoring of the flue gas will be performed over the entire length of the proposed testing. On each day of flue gas testing the following sequence will be implemented:

1. Arrive onsite, inspect condition of equipment.
2. Set up and leak check conditioning system through manifold.
3. Connect all three analyzers to manifold and individual strip chart recorders.
4. Perform initial calibration of all monitors with zero, mid and high span certified gases. Note and make any adjustments on the monitors. All calibration gases are introduced through the conditioning system sample probe.
5. Monitor O₂, CO₂ and CO throughout the flue gas testing making sure to mark the strip charts noting the beginning and end of the test runs.
6. At the end of the run, recalibrate the monitors and note all values on the appropriate data sheet to determine monitor drift.
7. Monitoring data will be reduced and presented as 15-minute averages.

The continuous monitoring system inspection, installation and operation will be performed in accordance with the Horiba Instruments Incorporated Instruction Manual.

4.2 SAMPLING PROCEDURES FOR SOLIDS

Sludge and ash samples will not be accurately weighed or measured in the field. The amount of sample collected will be kept approximately the same for each type of sample by using the specified size container and filling it to the indicated fraction of its capacity. The volumes cited below are based on that fraction and are included to give an estimate of sample size.

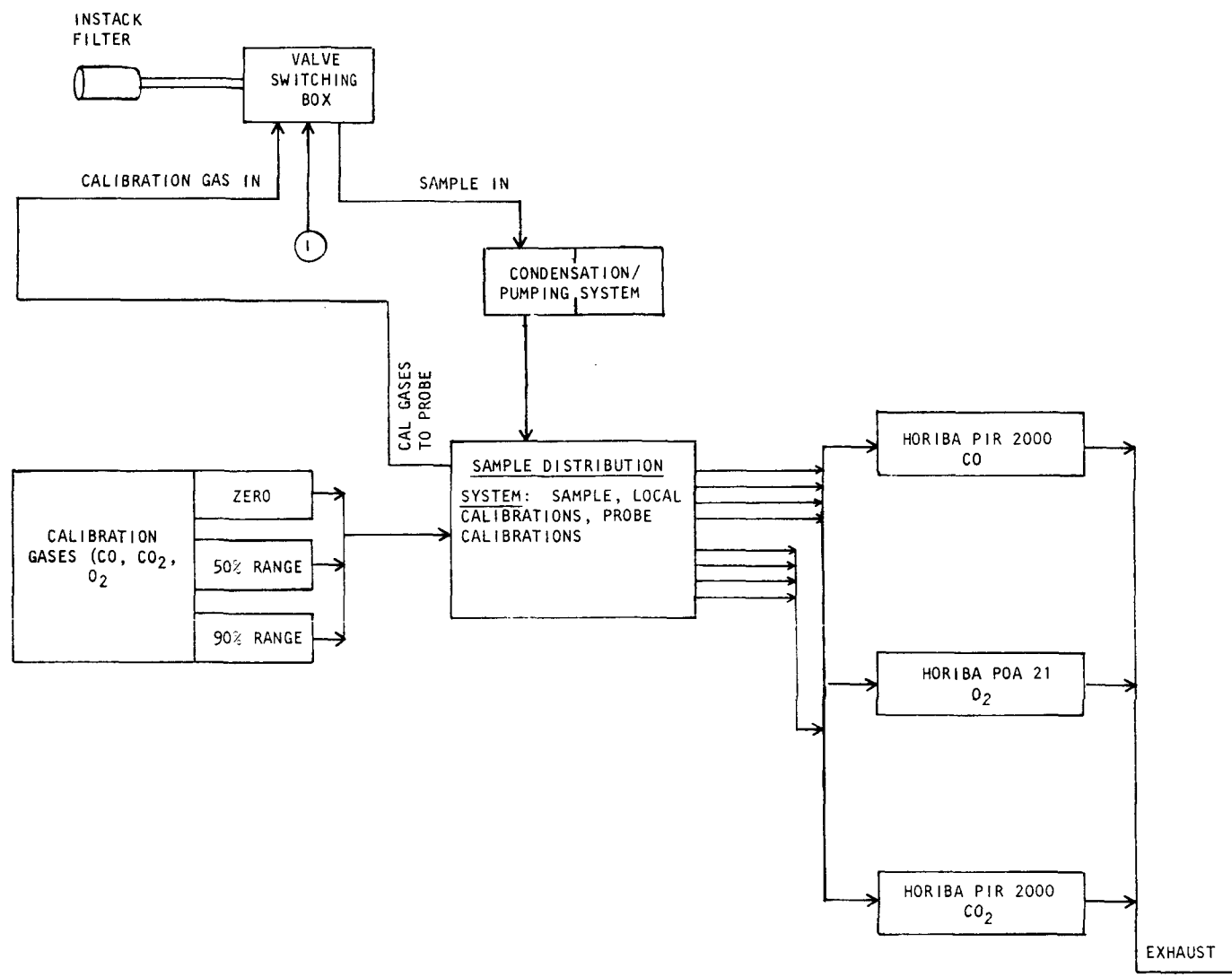


Figure 4-2. Continuous monitor flow schematic.

TABLE 4-1. ANALYZER SPECIFICATIONS OF CONTINUOUS MONITORS

	Horiba PIR 2000 CO ₂ Analyzer	Horiba PIR 2000 CO Analyzer	Horiba POA 21 OPE 315 O ₂ Analyzer
Operating Sensitivity Ranges	0-5% CO ₂ , FS 0-15% CO ₂ , FS 0-25% CO ₂ , FS	0-500 ppm CO, FS 0-1500 ppm CO, FS 0-2500 ppm CO, FS	0-5% O ₂ , FS 0-20% O ₂ , FS 0-50% O ₂ , FS
Operating Temperature Ranges	24 ^o F - 122 ^o F	24 ^o F - 122 ^o F	32 ^o F - 122 ^o F <95% Humidity
Analysis Method	Nondispersive Infared	Nondispersive Infared	Polargraphic
Linearity	+ 1% FS - 1% FS	+ 1% FS - 1% FS	+ 0.5% of Full Scale - 0.5% of Full Scale
Accuracy	+ 1% of Full Scale - 1% of Full Scale	+ 1% of Full Scale - 1% of Full Scale	+ 1% of Full Scale - 1% of Full Scale
Drift	+ 1% of Full Scale - 1% of Full Scale in 24 hours in both zero and span	+ 1% of Full Scale - 1% of Full Scale in 24 hours in both zero and span	< 5% Full Scale for 24 hours in both zero and span
Noise Level	<0.5% of Full Scale in most sensitive range	<0.5% of Full Scale in most sensitive range	< .25% of Full Scale in most sensitive range

A grab sampling procedure will be used to obtain a series of seven sludge samples during each test run. The sludge sampling location will be at the end of the screw conveyor, as the sludge enters the incinerator. Grab samples, each approximately 50 ml in volume, will be collected at the beginning and at 30 minute intervals throughout each test run. These samples will be collected in 250 ml wide mouth amber glass jars with teflon-lined caps. The 28 jars, seven for each test run, will be clearly labeled in sequential order, maintained at 4°C and then transported to the laboratory for analysis.

Ash samples will also be obtained by grab sampling. These samples will be taken from the ash storage hopper at the beginning, and at 60-minute intervals during each test run. Sample size will be approximately 75 ml or one third of a 250 ml wide-mouth amber glass jar. All ash samples from one test will be transferred and composited in a 500 ml wide-mouth amber glass bottle with a teflon-lined cap. The three composite bottles, one for each test run, will be clearly labeled, maintained at 4°C and transported to the laboratory for analysis.

4.3 SAMPLING PROCEDURES FOR WATER

The precooler/scrubber water feed will be sampled from a tap located on the precooler inlet. Four 250 ml samples will be taken at 45-minute intervals. These samples will be transferred and composited in a 1250 ml wide mouth amber glass bottle with a teflon-lined cap. The three composite bottles shall be clearly labeled and then transported to the laboratory for analysis.

Samples of the precooler/scrubber water effluent will be taken from a tap located on the scrubber drain line at 45-minute intervals during each test run. The volume of each sample will be 500 ml. The samples will be transferred and composited in a 3000 ml wide mouth amber glass bottle with a teflon-lined cap. The three composite bottles will be clearly labeled, maintained at 4°C and then transported to the laboratory for analysis.

4.4 ADDITIONAL SAMPLING QC CONSIDERATIONS

A primary factor in the successful accomplishment of this program will be the pre-test coordination of field and laboratory staff members, concerning sample containers, adsorbents, solvents, impinger solutions and field reagent

blanks. Such planning will minimize the possibility of inadvertent sample contamination in the field. Additional information on field/laboratory coordination is contained in Section 5.0, Sample Custody.

The preparation of all glassware will involve the following sequence: acid soak, alcoholic KOH soak (performed to eliminate visible greases, if present), deionized water rinse, acetone rinse and hexane rinse. Glass sample bottles with Teflon-lined caps and glass petri dishes for the storage of Method 5 particulate filters will be prepared in the same manner.

A blank will be generated in the field for each sorbent, solvent and reagent used in sampling. These field-biased reagent blanks will be later used to correct for any analytical interferences introduced during sample recovery. In addition to reagent blanks, there will be a blank train set up and recovered with the sample trains. These field-biased blank trains will provide a check on the cleanliness of sampling equipment and set-up procedures.

4.5 PREPARATION OF REAGENTS AND SOLVENTS

Organic solvents and laboratory water will be checked for purity before use. All organic solvents will be Burdick and Jackson "Distilled in Glass" grade or J. T. Baker "Resi-Analyzed" grade; the laboratory water is provided by a Continental Water Systems Corporation Cartridge System and meets ASTM criteria for Type I water.

The florisil adsorbent and glass wool packing will be soxhlet-extracted for 20 to 24 hours using a mixture of 85 percent hexane and 15 percent methylene chloride. The florisil will be subsequently dried and activated at 130°C for at least 16 hours before packaging and sealing in adsorbent tubes.

The XAD-2 resin will be soxhlet-extracted using the sequence described in the IERL-RTP Procedures Manual: Level 1 Environmental Assessment (EPA-600/7-89-201). As a quality control check on the cleaned XAD-2, two 50-100 g samples of the cleaned resin will be soxhlet extracted in methylene chloride for 16 to 24 hours. After drying and concentration to 2 ml, the extract will be subjected to Total Chromatographable Organics (TCO) and Gravimetric (GRAV) analysis. The acceptance limits are, for TCO, 10 µg/g and for GRAV, 20 µg/g.

All samples will be maintained at 4°C until the time of transfer to the GCA/Technology Division Sample Bank.

5.0 SAMPLE CUSTODY

The purpose of chain-of-custody procedures is to document the identity of the sample and its handling from its first existence as a sample until analysis and data reduction are completed. Custody records trace a sample from its collection through all transfers of custody until it is transferred to the analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition.

5.1 FIELD SAMPLING OPERATIONS

The importance of uncontaminated reagents, collection media and sample containers in collecting valid samples is well recognized by GCA. The collection medium actually becomes part of the sample itself.

Figure 5-1, the Field Reagent Prep Data Sheet, is used to document the preparation of absorbing solutions and reagents brought to the field collection site. The Field/Laboratory Procedure Coordination Form shown in Figure 5-2 is initiated by the Environmental Measurements Department (Field) for all sample collection projects involving analysis of the collected samples at GCA or elsewhere. Each type of sample to be collected is listed individually and assigned a unique identification number. Based on the type of sample and the analysis to be performed, the appropriate sample container and field preservative are specified. Approved lots of solvents and reagents are listed by the Laboratory Analysis Department QC Coordinator who must give final approval to the form. One or both of these forms are used as appropriate to the sample collection task.

Preprinted sample identification tags are used by GCA to ensure that the required information is entered in the field. Each collected sample including duplicates and field blanks shall have a completely filled-in sample tag securely attached. In addition, the sample identification number is marked on the container with a permanent marker so that the sample can be properly identified even if the tag is separated from the sample.

Figure 5-3 shows the general use GCA sample label and chain-of-custody seal that will be used to identify and seal samples in the field. Figure 5-4 shows a general use chain-of-custody record. This three-part carbonless copy

FIELD REAGENT PREP DATA SHEET

Reagent _____ Job # _____

Species Sampled _____ Client _____

Prepared By _____ Date _____ Exp. Date _____

Reagents Used _____ Circle: DDW D1 H₂O Other* _____

Reagent _____ Reagent _____ Reagent _____

Mfg/Lot # _____ Mfg/Lot # _____ Mfg/Lot # _____

*Other: _____

Procedure: _____

Weights/Volumes	
Final	_____
Initial	_____
Final	_____
Initial	_____
Final	_____
Initial	_____

QC Check _____

Figure 5-1. Field Reagent Prep Data Sheet.

The purpose of this form is to document prior approval from the Analytical Laboratory representative that the reagents, materials and procedures used in sample collection tasks are compatible with subsequent laboratory analysis requirements.

Contract Number: _____

[illegible]

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Figure 5-2. Field/Laboratory Procedure Coordination form.

GCA TECHNOLOGY DIVISION ●●▲

DATE: _____ SAMPLE NO.: _____

SAMPLE DESCRIPTION: _____

SAMPLE METHOD: _____

ADJUSTMENTS: _____

COLLECTED BY: _____

COMMENTS: _____

SHIPPED: _____ REC'D: _____


 GCA/Technology Division Chain of Custody Sample Seal	FIELD SAMPLE NO		DATE	SEALERS INITIAL
	RUN #	SAMPLE DESCRIPTION		
	SEALERS NAME (PRINT)		SEAL BROKEN BY & DATE	

Figure 5-3. Sample Label and Chain of Custody Seal.

[illegible]

form is based on NEIC format and will be used to document sample transfer in the field and from sampling personnel to the laboratory.

5.2 LABORATORY OPERATIONS

All samples submitted to the GCA/Technology Division Analytical Laboratory will be brought to the Sample Bank Manager, Jackie Ferragut, who will continue the chain of custody by assigning a GCA Control Number to each sample on receipt; this number identifies the sample through all further handling. The sample will be recorded in the bound Master Sample Log under its GCA Control Number. A Master Log page is not depicted here because the hand-written records do not reproduce well; however, each page of the Master Log has the following format:

- GCA Control Number
- Sample description
- Sample condition
- Signature of person completing sample record
- Date of sample receipt

GCA/Technology Division maintains large, locked, refrigerated and nonrefrigerated storage areas with provision for hazardous material storage. After necessary preservation or subdivision, the Sample Bank Manager will store each sample in the appropriate area under its GCA Control Number.

The Sample Bank Manager will initiate a page (Figure 5-5) for each sample in the Custody Book and ensure that each handling of the sample is appropriately documented. Each analyst working with the sample will first go to the Sample Bank Manager and record in the Custody Book actions taken on the sample thereby maintaining the chain of custody of the original sample.

When sample preparation and analysis procedures necessitate the transfer of samples between two analysts within the laboratory, a Sample Custody Transfer form (Figure 5-6) is required. This document serves as a supplement to the Custody Notebook record of sample handling and becomes part of the permanent project file.

Figure 5-5. Custody book page.

SAMPLE CUSTODY TRANSFER

PURPOSE

Procedure/Analysis required _____

(General information only — analyst MUST refer to Project File for specific details.)

Instrumentation required _____

BACKGROUND

Client _____

Contract (Charge) No. _____ Work Order No. _____

SAMPLES

General description of sample type(s) _____

List of samples (by GCA Control No.):

Additional samples (QC-blanks, QC-spikes, etc.):

Total number of samples _____

Comments _____

TRANSFER

From _____ Date _____

Received by _____ Date _____

(Location of samples _____)

When completed, make 3 copies — one each for originator, recipient, and Task Manager.

RETURN ORIGINAL TO PROJECT FILE.

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Figure 5-6. Sample Custody Transfer form.

All materials such as field and laboratory notebooks and logbooks, field and laboratory data records, correspondence, reports, sample tags, chain-of-custody records and instrument printouts will be clearly labeled with the project number and become a permanent part of the project file.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibration procedures for field and laboratory instrumentation are described in the following sections.

6.1 SOURCE SAMPLING EQUIPMENT

Calibration of the field sampling equipment will be performed, prior to and at the conclusion of, the field sampling effort. Copies of the initial calibration sheet will be submitted to the field team leader to take onsite for reference, and to the project file. Calibrations will be performed as described in the EPA publication "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods;" acceptance limits are listed below.

- Sample meter system--leak checked, then compared against a wet test meter to a ratio average of $Y \pm 0.01Y$.
- Thermocouples--compared to mercury in glass thermometer to accuracy of ± 1.5 percent, or the use of a constant correction factor.
- Field Barometer--calibrated initially versus mercury in glass barometer to ± 0.01 in. Hg. The calibration will be checked before and after each field test.
- Nozzles--calibrated with micrometer to the nearest 0.001 inch.
- Triple beam balance--checked with class S weights to ± 1 mg.
- Type S pitot tube and probe assembly--All dimension specifications are met or calibrated against Type P pitot. Mounted in an interference free manner.
- Calibration of continuous monitors. All calibration gases will be purchased as prepared EPA protocol 1 calibration gases. The instruments will be calibrated prior to the burn by injecting through the probe standards corresponding to 0, 50 and 90 percent of the analytical range. Responses resulting from these injections will be subsequently used to construct a calculation equation in the form:

$$\text{ppm (\%)} = M (\% \text{ chart}) + b$$

where ppm (%) is the concentration of the gas being measured,
% chart is the response noted on the strip chart recorder,
M and b are the slope and intercept of the equation.

The calibration equation will be constructed by plotting the span gas and resulting responses as shown in Figure 6-1. A line of best fit will be drawn through the span gas coordinate pairs. If all points do not fall on the best fit line, the line will be passed through the zero pair and averaged between the upper two span responses. The calibration equation will be calculated from the plot as follows:

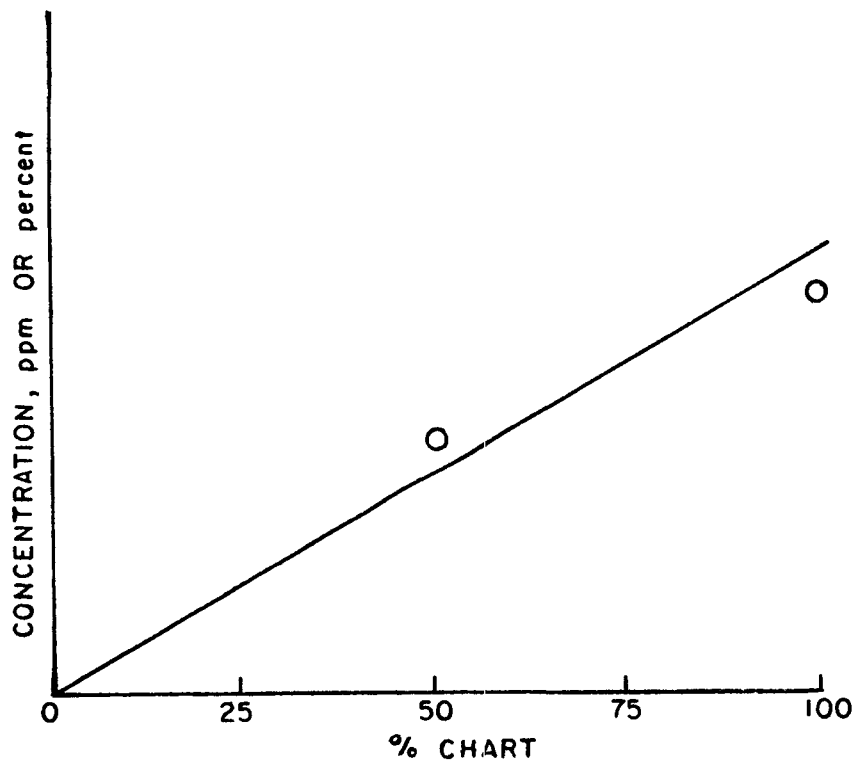


Figure 6-1. Determination of a calibration equation.

Determine the slope (m) as follows:

$$M = \frac{Y_1 - Y_2}{X_1 - X_2}$$

where X_1 , Y_1 and X_2 , Y_2 are coordinate pairs determined by the best fit line.

The intercept (b) is determined as follows:

$$b = \left(\frac{\% \text{ chart}}{100} \right) \text{conc. at full scale}$$

The acceptance procedure for an initial calibration involves inserting the responses obtained from the gas injections into the calibration equation and solving for the concentration. The result calculated from the equation is compared for difference to the accepted value of the gas as follows:

$$\% \text{ error} = \frac{\text{Obs} - \text{Acc}}{\text{Acc}} \times 100$$

where Obs is the calculated value
Acc is the accepted value of the calibration gas.

If both upscale spans are within ± 2.5 percent error, the calibration is acceptable. For cases where this criteria are not met the instrument linearity (for NDIRS) and/or span gas values must be checked.

6.2 ANALYTICAL INSTRUMENTATION

6.2.1 Hewlett-Packard 5840A Gas Chromatograph with Ni⁶³ Electron Capture Detector

Calibration Standards--

1. Prepare stock solutions for each Aroclor at concentrations of 1 $\mu\text{g}/\mu\text{l}$ using materials available from the EPA/RTP Reference Standards Repository. Chlorinated biphenyl standards will be

prepared using materials obtained from Ultra Scientific, Inc., Hope, Rhode Island. Use the specified purity of each lot of the compound in calculating the standard concentration. Prepare stock solutions every 6 months or as needed.

2. Prepare the working standards by dilution of the stock solution. The working standards will be prepared as needed.
3. Verify working standard solutions by analysis of Aroclor quality control check samples (EPA/EMSL, Cincinnati, Ohio) before use as calibration standards.

Calibration Procedures--

1. Calibrate the instrument daily using 4 to 5 calibration (working) standards.
2. Analyze a laboratory control sample. If the reported values are within 10 percent of the expected values, analysis may proceed.
3. Enter all instrument operating conditions and quality control results in the instrument logbook. The analyst's notebook must contain all information regarding standard preparation. Sign and date all entries.

6.2.2 Hewlett-Packard 5985 GC/MS

Calibration Standards--

1. Prepare stock solutions of the chlorinated biphenyls at a concentration of 1 $\mu\text{g}/\mu\text{l}$ using materials obtained from Ultra Scientific, Inc., Hope, Rhode Island. Use the specified purity of each compound lot in calculating the standard concentration. Prepare stock solutions every 6 months or as needed.
2. Prepare working standards by dilution of the stock solutions. The working standards are prepared as needed.
3. Verify standard solutions by analysis of an independent standard. If possible, standards for the various isomers will be obtained from Dr. David Longfellow, Bethesda, Maryland; these standards will be used for verification of the commercial standards before their use as calibration standards.

Calibration Procedures--

1. Calibrate the instrument daily using a minimum of three calibration (working) standards.
2. The following instrumental conditions are normally used:

GC Conditions

- column 1.5 percent OV-17/1.95 percent QF-1 on 100/120 Chromosorb WHP, 6 ft x 2 mm
- injection
 - mode splitless
 - temperature 225°C
- temperature program 160°C for 2 minutes, then 5°C/min to 225°C and hold.

Mass Spectrometer Conditions

- mode mass scan 50 to 450 amu
- electron energy 70 eV
- scan time 0.8 sec/scan

3. Analyze a laboratory control sample. If the reported values are within established acceptance limits (generally ± 20 percent), analysis may proceed.
4. Enter all instrument operating conditions and quality control results in the instrument logbook. The analyst's notebook must contain all information regarding standard preparation. Sign and date all entries.

7.0 ANALYTICAL PROCEDURES

As discussed in Section 4.0, Sampling Procedures, a single sampling train will be utilized during each of the three test runs. This single train will permit collection of PCBs as well as chlorinated dibenzofurans and chlorinated dioxins, combustion by-products potentially formed during the incineration process.

7.1 FLUE GAS SAMPLES - PARTICULATE

A total of three runs will be conducted for stack gas emissions. Each of these trains will generate five types of samples: (1) impingers/condensates; (2) combined train (solvent) rinses; (3) a florisil cartridge; (4) an XAD cartridge; and (5) particulates collected on a filter. The combined probe rinse and particulate filter sample will constitute the particulate sample. Analysis of these samples will proceed in the following manner.

1. Record particulate weights for each of the recovered filter catches and probe rinses.
2. Aliquot the filters, and probe rinse solids and combine the aliquots of each for extraction.
3. Surrogate spike the combined sample from each run with an appropriate deuterated analogue and soxhlet extract for 24 hours in methylene chloride.
4. Reduce each extract to 3.0 ml using a Kuderna-Danish evaporative concentrator.
5. Remove 1.0 ml of the 3.0 ml extract and maintain in reserve. Subject 1.0 ml to alumina column cleanup and then separately reduce it and remaining 1.0 ml aliquot to 0.5 ml via the N₂ blowdown prior to GC/MS analyses.
6. Analyze the extracts by selected ion monitoring GC/MS for polychlorinated dioxins and polychlorinated dibenzofurans. Instrument calibration will be provided for a variety of chlorinated dioxins and chlorinated dibenzofurans; a list of representative isomers for the GC/MS screening protocols is shown below:
 - Dibenzofuran
 - 2,8-Dichlorodibenzofuran

- Dibenzo-p-dioxin
- 1-Chlorodibenzo-p-dioxin
- 2-Chlorodibenzo-p-dioxin
- 2,6-Dichlorodibenzo-p-dioxin
- 1,2,4-Trichlorodibenzo-p-dioxin
- 1,2,3,4-Tetrachlorodibenzo-p-dioxin

7. Analyze each of the same extracts for each of ten PCB positional isomer categories again employing GC/MS procedures.

Use of the following representative PCB isomers is suggested:

- Biphenyl
- 2-Chlorobiphenyl
- 4-Chlorobiphenyl
- 3,3'-Dichlorobiphenyl
- 2,5'-Dichlorobiphenyl
- 2,3',5-Trichlorobiphenyl
- 2,4,5-Trichlorobiphenyl
- 2,3',4',5-Tetrachlorobiphenyl
- 2,2',4,4',5-Pentachlorobiphenyl
- 2,2',4,4',6,6'-Hexachlorobiphenyl
- 2,2',3,4,5,6,6'-Heptachlorobiphenyl
- 2,2',3,3',4,4',5,5'-Octachlorobiphenyl
- 2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl
- 2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl

8. Analyze each of these same extracts for other organic components not members at the PCB, PCDD or PCDF chemical categories.

7.2 FLUE GAS SAMPLES - GAS PHASE (SORBENTS/IMPINGERS, ETC.)

The remaining sample types from each train will constitute the gas phase portion of each flue gas sample set. This will include the following types of samples: solvent rinses, condensate, aqueous impinger, florisil sorbent and XAD-2 sorbent. The analysis of these samples will proceed as follows:

1. Transfer the impinger condensate waters from the sampling train to a separatory funnel and extract with three 100 ml portions of methylene chloride. Combine these extracts with that of the florisil tube, XAD-2 extract and the corresponding hexane/acetone train rinses.
2. Surrogate spike each XAD-2 cartridge and soxhlet extract with methylene chloride overnight. Retain the solvent extract for combination with the impinger extracts and train rinses.
3. Surrogate spike the contents of each florisil tube using appropriate deuterated analogues and soxhlet extract with hexane overnight. After cooling, the solvent extract will be combined with the impinger/condensate extract, XAD-2 extract and corresponding train rinse.
4. Dry the combined extract using a sodium sulfate column and concentrate to 3.0 ml using a Kuderna-Danish apparatus.
5. Remove 1.0 ml for reserve. Subject 1.0 ml to alumina column cleanup and separately reduce it and the remaining 1.0 ml to 500 μ l using N_2 blowdown.
6. Proceed with GC/MS analyses for PCBs, PCDDs, PCDFs, and other organics as noted earlier for flue gas particulate samples.

7.3 SLUDGE FEED SAMPLES

7.3.1 GC/ECD Analysis

1. Remove a 10 g aliquot from each of the 21 grab samples. Air-dry the sample and soxhlet extract with 1:1 hexane: acetone according to the procedure detailed in Reference 7.
2. Concentrate the extract to 5.0 ml by rotary evaporation or using a Kuderna-Danish apparatus.
3. Submit an aliquot of each extract for PCB analysis using a gas chromatograph fitted with an electron capture detector (GC/ECD).

4. All GC/ECD measurements will be conducted on a gas chromatograph fitted with a Ni⁶³ electron capture detector (e.g., HP5840A). All gas chromatographic peaks will be recorded and integrated using an appropriate data system. Qualitative pattern matching, if needed, will be provided after comparison of the sample elution pattern with Aroclor mixtures.
5. Pattern recognition procedures should be used for quantitation (peak summation). Samples displaying a complex or indistinguishable pattern may warrant Alumina⁸ column or acid-partitioning.¹⁰ Webb-McCall procedures should be substituted for samples not displaying a complete Aroclor pattern.
6. All data should be reported on both a dry and wet weight basis (mg/kg). The detection limit for these analyses should be 1 ppm (mg/kg) on a dry weight basis.

7.3.2 GC/MS Analysis

1. Remove a 1.0 ml aliquot from each of seven sludge extracts for each test run. Combine these aliquots to create a composite sample for each of the three runs.
2. Fortify each of these composite samples with a surrogate cocktail.
3. The combined extract should be reduced to 100 µl using a stream of nitrogen.
4. Proceed with PCB analyses (positional isomers) as noted before for flue gas samples.

7.4 HOPPER ASH SAMPLES

1. Composite 35 g from each of three grab samples taken during each test series.
2. Spike each 105 g sample with a surrogate mixture and extract overnight with methylene chloride in a soxhlet apparatus.
3. Reduce each extract to 10.0 ml using a Kuderna-Danish apparatus. Remove 3.0 ml for reserve.
4. Reduce a 3.0 ml aliquot to the minimum attainable volume.
5. Subject 3.0 ml to alumina column cleanup and concentration to the minimum attainable volume.
6. Proceed with GC/MS analyses for PCBs, PCDDs, PCDFs and other organics as before for flue gas samples.

7.5 AQUEOUS SAMPLES

Analyses will be conducted on the following types of water samples:

- Precooler/Scrubber Water Feed - 3 grab samples per run. These should be composited so as to create a single representative sample per run (e.g. one liter total).
- Scrubber Water Effluent - 3 grab samples per run. Composite into a single representative sample per run (e.g. one liter).
- Centrifuge Water - 3 grab samples per run. Composite into a single sample per run. May require filtration prior to extraction due to large quantities of solids. If this is the case then aqueous samples should be analyzed as described below and solid filtered material should be analyzed separately per sludge analysis procedure.
- Plant Influent Wastewater - 3 grab samples per run. Each of these should be analyzed separately.
 1. Extract 1 liter samples of each of the above with methylene chloride per procedures outlined in EPA Method 608.¹⁰
 2. Dry extracts using a sodium sulfate column and concentrate to 10.0 ml using a Kuderna-Danish apparatus.
 3. Proceed with gas chromatographic (GC/ECD) analyses discussed earlier for sludge feed samples. Detection limits of 1 µg/l are needed. GC/MS analyses will also be required for these samples, since the GC/ECD will serve only as a screening tool.

7.5.1 GC/MS - Scrubber Effluent

1. Reduce 5.0 ml aliquot of each extract to 100 µl using a stream at prepurified N₂.
2. Proceed with GC/MS analysis for each of ten PCB positional isomer categories as stated earlier for flue gas samples.

7.5.2 GC/MS - Plant Influent Wastewater

1. A single composite sample should be prepared from the three grab samples taken during each run.
2. Extract one liter composite sample with methylene chloride and proceed with analysis as in EPA Method 625.

3. Provide results in $\mu\text{g/l}$ for major components in each extract (acids, base-neutrals, other major compounds).

7.5.3 GC/MS - Scrubber Water Feed/Precooler Centrifuge Water

Samples containing elevated levels of PCBs will require GC/MS analysis to include: qualitative analysis for PCBs (presence or absence confirmation). In this instance, 1/2 (e.g. 5.0 ml) of the existing extract should be reduced in volume using N_2 to 100 μl (PCB confirmation using total ion mode should be used). In addition, each of these extracts should simultaneously undergo GC/MS analyses for the identification and quantitation of major components with particular emphasis on chlorinated organics (e.g., chlorinated pesticides, chlorinated benzenes, chlorinated naphthalenes (PCNs)). Again, these analyses should be conducted in accordance with procedures provided earlier for flue gas samples.

8.0 DATA REDUCTION, VALIDATION AND REPORTING

Extensive QC measures will be used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in all projects.

8.1 FIELD DATA REDUCTION

Appendix A of this QA Plan presents the standardized forms that will be used to record sampling data. The data collected will be reviewed in the field by at least two field crew members. Errors or discrepancies will be noted in the field log book.

Figure 8-1 shows the data flow scheme; Appendix B gives the calculations used to determine concentrations. In practice, these forms are used as worksheets in the field to check on isokinetic sampling conditions. The bulk of the data is computer-processed at GCA to yield the following information:

- Particulate emissions
 - Grains per standard cubic foot
 - Grains per standard cubic foot at 12 percent CO₂
 - Pounds per hour
- HCl emissions
 - ppm, actual
 - pounds per hour
- Organic emissions
 - ppm, actual
- Volumetric flow rate
 - Cubic feet per minute, dry basis, standard conditions
 - Cubic feet per minute, actual

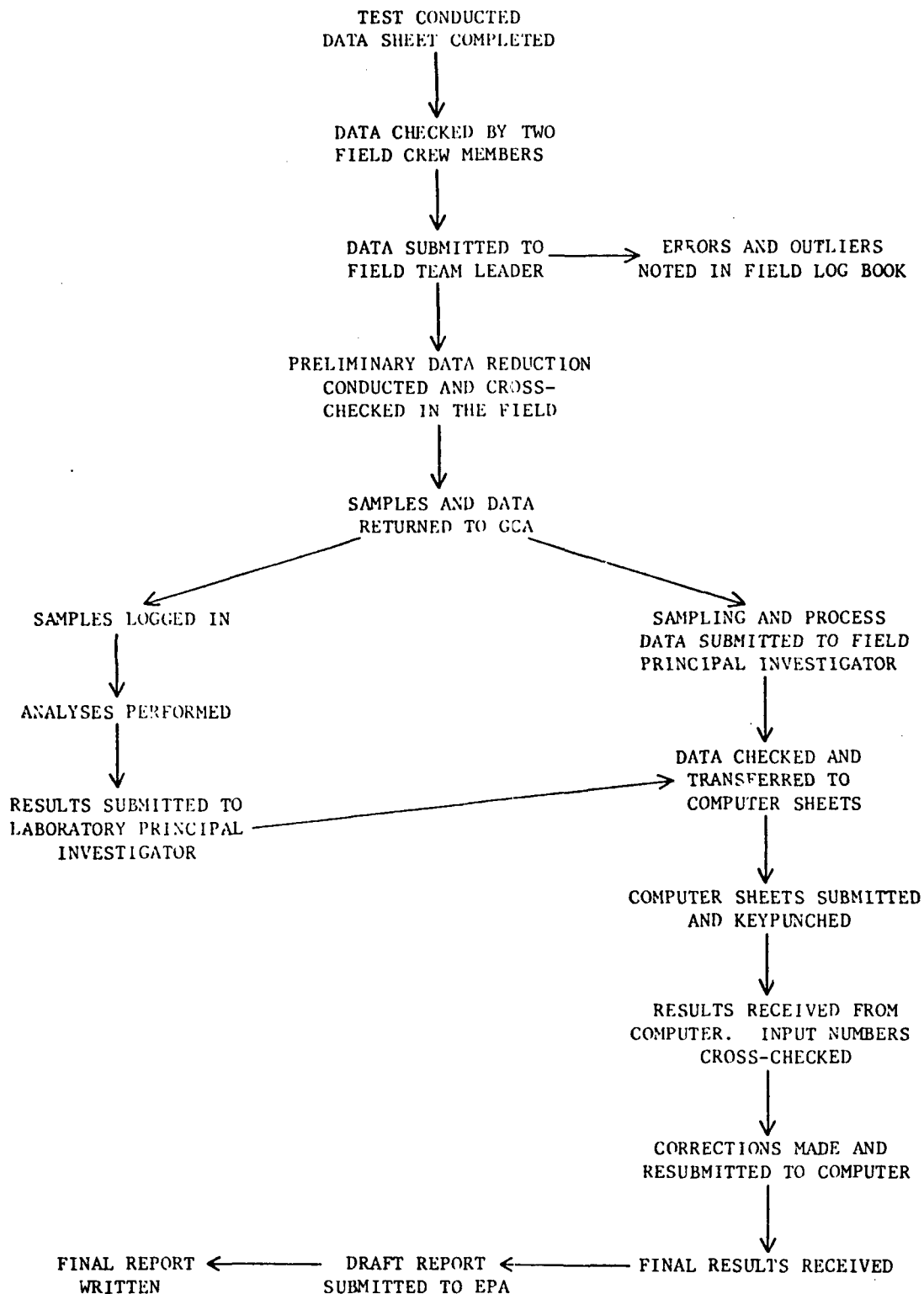


Figure 8-1. Data flow scheme.

- Continuous Monitoring Data--the monitoring data will be reduced and presented in terms of 15 minute averages for the parameters listed below:
 - Carbon monoxide--ppm
 - Carbon dioxide--percent
 - Oxygen--percent
- Dry molecular weight--to nearest tenth gram
- Liquid grab samples
 - Weight per unit volume
- Solid grab samples
 - Weight per unit volume

8.2 LABORATORY ANALYSIS DATA REDUCTION

Analysis results will be reduced to concentration units specified in EPA's instructions or the analytical procedure, using the equations given in the analytical procedures. If units are not specified, data from the analysis of water samples will be reported in units of mg/l. Data from the analysis of solid samples will be converted to units of mg/kg using the following equation:

$$X_w = X_v \times V \times \text{d.f.} \div w$$

where X_w = reported value, mg/kg

X_v = reported sample value, mg/l

V = sample volume, l

d.f. = dilution factor

w = sample weight, kg

Data from the analysis of air samples will be reported as $\mu\text{g}/\text{m}^3$. This will be calculated by dividing the total weight of the substance detected by the volume of air sampled. Appropriate blank corrections will be applied in all cases.

8.3 DATA VALIDATION

Data validation is the process of filtering data and accepting or rejecting it on the basis of sound criteria. GCA/Technology Division supervisory and QC personnel will use validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data will be maintained, even that judged to be an "outlying" or spurious value. The persons validating the data will have sufficient knowledge of the technical work to identify questionable values.

The following criteria will be used to evaluate the field sampling data:

- Use of approved test procedure
- Steady state operation of the process
- Use of properly operating and calibrated equipment
- Leak checks conducted before and after tests
- Use of reagents that have passed QC checks

The criteria listed below will be used to evaluate the analytical data:

- Use of approved analytical procedure
- Use of properly operating and calibrated instrumentation
- Acceptable results from analyses of EPA QC samples for PCBs in water and sediment (i.e., the reported values should fall within the EPA 95 percent confidence interval for these samples)
- Precision and accuracy achieved should be comparable to that achieved in previous PCB analytical programs

8.4 IDENTIFICATION AND TREATMENT OF OUTLIERS

Any data point which deviates markedly from others in its set of measurements will be investigated; however, the suspected outlier will be recorded and retained in the data set while it is investigated. One or both of the following tests will be used to identify outliers.

Dixon's test for extreme observations^{11,15} is an easily computed procedure for determining whether a single very large or very small value is consistent with the remaining data. The one-tailed t test for difference¹¹ may also be used in this case. Reference 10 contains calculation formats and tables of critical values for these tests. It should be noted that these tests are designed for testing a single value. If more than one outlier is suspected in the same set of data, the statistical sources listed will be consulted and the most appropriate test of hypothesis will be used.

Since an outlier may result from unique circumstances at the time of sample analysis or data collection, those persons involved in the analysis and data reduction will be consulted. This may provide an experimental reason for the outlier. Further statistical analyses will be performed with and without the outlier to determine its effect on the conclusions. In many cases, two data sets will be reported, one including and one excluding the outlier.

In summary, every effort will be made to include the outlying value in the reported data. If the value is rejected, it will be identified as an outlier, reported with its data set and its omission noted.

8.5 DATA REPORTING

Figure 8-1 shows the field data reduction, validation and reporting process; Figure 8-2 depicts the analytical data reduction, validation and reporting process. Key personnel who will handle data gathering and evaluation are shown in Figure 2-1, the Project Organization Chart.

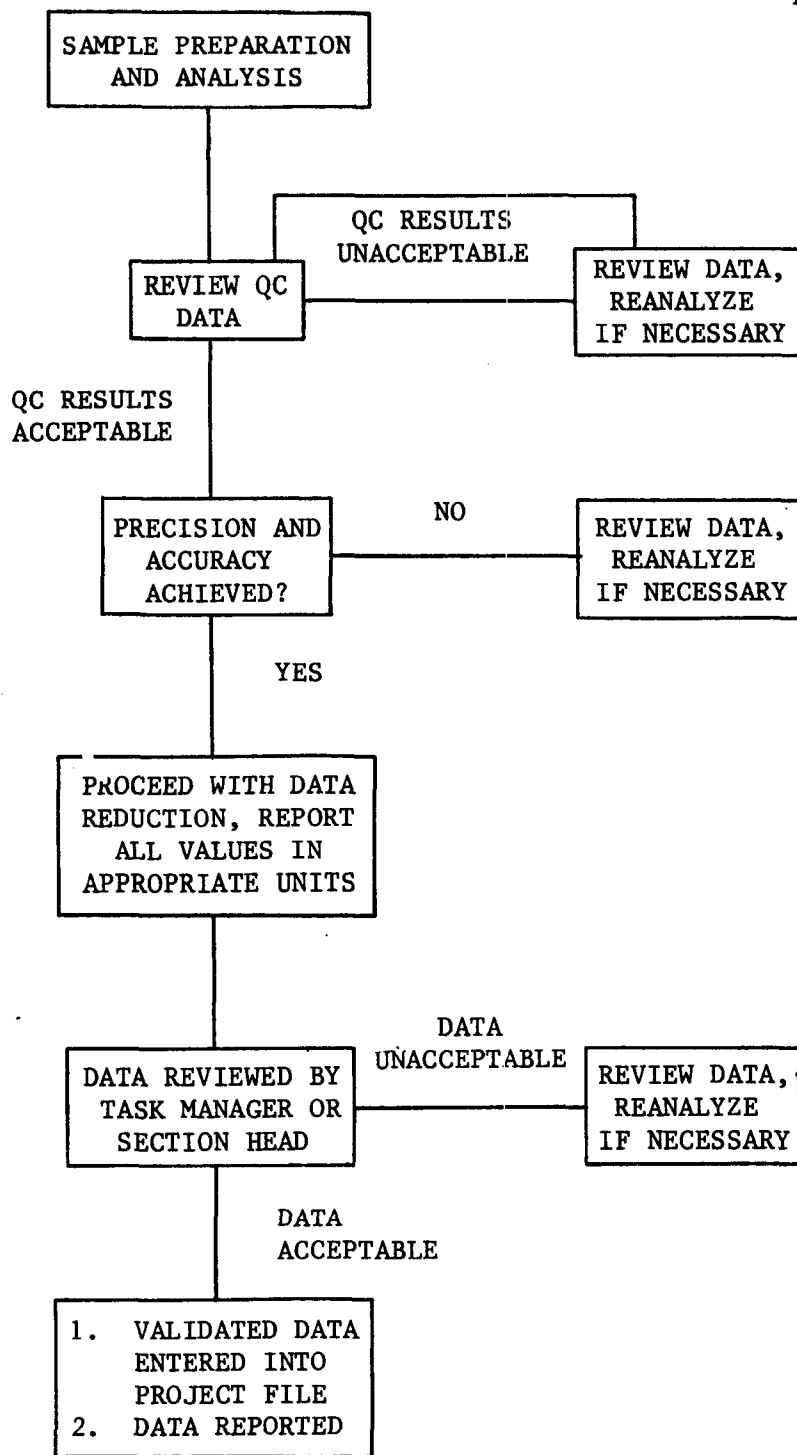


Figure 8-2. GCA analytical data reporting scheme.

9.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Quality control checks will be performed to ensure the collection of representative samples and the generation of valid analytical results on these samples. These checks will be performed by project participants throughout the program under the guidance of the QA Manager and the Field and Laboratory Department QC Coordinators.

9.1 SAMPLING QC PROCEDURES

9.1.1 Sampling Equipment QC Checks and Frequency

Calibration of the field sampling equipment will be performed, prior to and at the conclusion of, the field sampling effort. Copies of the calibration sheet will be submitted to the field team leader to take on site for reference, and the project file. Calibrations will be performed as described in the EPA publication "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods;" Section 6.1 presents acceptance limits.

9.1.2 Span Drift Check of Continuous Monitors

The continuous monitoring equipment will be checked during the course of each test by inputting a combination span gas through the probe for analysis. This gas will correspond to the CO and O₂ limits (80 ppm and 3 percent, respectively). The CO₂ span gas will contain approximately 12 to 13 percent CO₂ (mid-span level). Since these gases are all contained in the same cylinder, the use of this technique does not take the monitors out of service for any appreciable time period.

The responses obtained from these span checks will be reduced into units of concentration using the appropriate calibration equation. These data will be plotted on a control chart to determine if a significant drift has occurred. Limits on the control charts are as follows:

- CO--100 \pm 12 ppm
- O₂--6 \pm 0.5 percent
- CO₂--13 \pm 0.3 percent

These limits were determined by using the 24 hour drift criteria (contained in PST No. 2: 2.5 percent of span). Data falling outside the chart limits will necessitate corrective actions.

9.1.3 Sample Collection QC Checks

Field-biased blanks of reagents and collection media (deionized water, filters, florisil, XAD-2, solvent rinses, etc.) will be placed in appropriately cleaned and sized sample containers in the field and handled in the same way as actual field samples, to provide a QC check on sample handling. Samples will be collected in sequence or in duplicate to monitor the collection, handling and analysis procedures.

9.1.4 Sample Collection QC Checks and Frequency

- One blank modified Method 5 train of each sampling day.
- One field-biased blank on each reagent and collection medium used on each sampling day and not contained in the sampling trains.
- Seven sequential sludge samples during each test run.

9.2 ANALYTICAL QC PROCEDURES

GCA's Quality Control program for laboratory analysis makes use of a number of different types of QC samples to document the validity of the generated data. The following types of QC samples are used routinely:

1. Blank Samples

- a. Field-Biased Blanks--Blank samples which have been exposed to field and sampling conditions in order to assess possible contamination from the field.

- b. Method Blanks--Blanks which are processed through the sample preparation procedures to account for contamination introduced in the laboratory.
- c. Calibration Blanks--Blanks used in instrument calibration; these blanks contain the reagents used in preparing instrument calibration standards except the parameters of interest.
2. Duplicate Samples--A second aliquot of a sample carried through all sample preparation and analysis procedures to verify the precision of the analytical method.
3. Spiked Samples--Samples will be spiked with the parameters of interest at a level two to three times the method detection limit. Samples requiring organic analyses are routinely surrogate spiked with an appropriate deuterated analogue.
4. EPA QC Materials--EPA Quality Control check samples for PCBs in water (WP679 concentrates 1-16) or PCBs in Sediment (WP978, groups 1-3) will be used as appropriate.

Specific quality control protocols for this project will include the following:

- GC/ECD analysis of replicate sludge feed samples.
- GC/MS analysis of aqueous samples containing Aroclor spikes.
- GC/MS analysis of duplicate aqueous spikes containing series of PCB isomers.
- GC/MS analysis of duplicate spiked (PCB, PCDD, PCDF) sorbent samples (florisil, XAD-2).
- GC/MS analysis of duplicate lab spikes containing a series of PCB, PCDD and PCDF isomers.

The duplicate and spiked samples may be submitted as known QC samples, termed laboratory control samples (LCS), or "blind" QC samples, those which are not recognizable to the analyst. LCS are routinely used to ensure that the analytical process is in control. The type and frequency of use of each of these QC measures is summarized below.

- Instrument QC Checks and Frequency
 - daily calibration

- analyze LCS daily before sample analysis; reported values must be within established control limits
- analyze a calibration check sample after every 10 samples; reported value must be within 5 percent of original value.
- Preparation and Analysis Procedure QC Checks and Frequency
 - method blank with each group of 20 or fewer samples
 - laboratory control sample and duplicate with each group of 20 or fewer samples
 - "blind" quality control sample with each group of samples received.

Reagents used in the laboratory are normally of analytical reagent grade or higher purity; each lot of acid or solvent used is checked for acceptability prior to lab use. All reagents are labeled with the date received and date opened. The quality of the laboratory deionized water is routinely checked.

10.0 QUALITY ASSURANCE PERFORMANCE AUDITS, SYSTEM AUDITS AND FREQUENCY

GCA/Technology Division's quality assurance program includes both performance and system audits as independent checks of the quality of data obtained from sampling, analysis, and data gathering activities. Every effort is made to have the audit assess the measurement process in normal operation. Either type of audit may show the need for corrective action.

10.1 PERFORMANCE AUDITS

The sampling, analysis, and data handling segments of a project are checked in performance audits. A different operator/analyst performs these audit operations to ensure the independence of the quantitative results.

The EPA Project Officer will be requested to obtain audit gases for the continuous monitors. It is anticipated that the monitors will be audited once during the program. The results of the most recent Method 5 Interlaboratory Study will be reported as an audit of the Dry Gas Meters.

EPA Quality Control concentrates and NBS Standard Reference Materials will be used to assess the analytical work. The Laboratory QC Coordinator will direct the inclusion in the sample load of QC samples appropriate to the analyses performed in each batch of 20 or fewer samples so that they are not recognizable to the analyst. In addition, any appropriate interlaboratory study samples which are available during this program will be analyzed to further audit the analytical work.

10.2 SYSTEM AUDITS

A system audit will be conducted by the Division QA Manager at least once during the program to ensure that the elements outlined in the Project QA Plan are functioning.

10.3 EXTERNAL AUDITS

GCA will cooperate fully in any performance or system audits conducted or arranged by EPA. The QA Manager and Department QC Coordinators are available to aid in scheduling such audits.

11.0 PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

GCA/Technology Division follows an orderly program of positive actions to prevent the failure of equipment or instruments during use. This preventive maintenance and careful calibration helps to assure accurate measurements from field and laboratory instruments.

All equipment that is scheduled for field use is cleaned and checked prior to calibration. Once the equipment has been calibrated, sample trains are assembled and leak checked in order to reduce problems in the field. An adequate supply of spare parts is always taken in the field to minimize downtime from equipment failure. Upon return to GCA, an Equipment Evaluation is written and submitted to the department QC Coordinator to point out problems with critical equipment (sample trains, DTRs, pumps, pH meters, etc.) and ensure required maintenance is completed before use in the next project. Table 11-1 summarizes maintenance procedures and their frequency for field sampling equipment.

The CEM systems are operated and maintained in accordance to the Horiba operation manual. Maintenance is performed on a regular scheduled basis prior to use in the field. If extended down time of the monitors is incurred during the sample run an Orsat analyzer will be used. Hourly grab samples will be collected and analyzed for CO_2 , O_2 and CO .

In the analytical laboratories routine maintenance procedures are followed for glassware, water supply, reagents, and analytical balances. These procedures are contained in GCA's Analytical QC Manual. Table 11-2 summarizes maintenance procedures and their frequency for the major laboratory instrumentation to be used in this program.

TABLE 11-1. MAINTENANCE PROCEDURES AND FREQUENCY FOR
FIELD SAMPLING EQUIPMENT

Equipment	Maintenance procedure/frequency	Spare parts
Vacuum system	<ul style="list-style-type: none"> Before and after each sample trip; <ol style="list-style-type: none"> 1. Check oil and oiler jar 2. Leak check 3. Vacuum gauge functional Yearly or as needed; <ol style="list-style-type: none"> 1. Replace valves in pump 	Additional meter box
Manometer	<ul style="list-style-type: none"> Before and after each sample trip; <ol style="list-style-type: none"> 1. Leak check 2. Check fluid for discoloration or visible matter Yearly or as needed; <ol style="list-style-type: none"> 1. Disassemble and clean 2. Replace fluid 	Spare fluid
Dry gas meter	<ul style="list-style-type: none"> Before and after each sample trip; <ol style="list-style-type: none"> 1. Check meter dial for erratic rotation Every 3 months <ol style="list-style-type: none"> 1. Remove top plate and check for excessive oil or corrosion 2. Disassemble and clean 	
Nozzles	<ul style="list-style-type: none"> Before and after each test <ol style="list-style-type: none"> 1. No dents, corrosion or other damage 	
Miscellaneous		Fuses, fittings. Variable transformers.
Diaphragm pump	<ul style="list-style-type: none"> Before and after each test; <ol style="list-style-type: none"> 1. Leak check. Change diaphragm if needed. Yearly or as needed <ol style="list-style-type: none"> 1. Disassemble and clean 	
Orsat Analyzer	<ul style="list-style-type: none"> Before each test; <ol style="list-style-type: none"> 1. Leak check 2. Inspect for damage After each trip <ol style="list-style-type: none"> 1. Replace reagents after 10 runs 	Reagents
Tedlar bags	<ul style="list-style-type: none"> Before each test <ol style="list-style-type: none"> 1. Leak check 2. Inspect for damage 	

TABLE 11-2. MAINTENANCE PROCEDURES AND SCHEDULE FOR MAJOR INSTRUMENTATION

Instrument	Maintenance procedure/schedule	Spare parts
Hewlett-Packard 5840A Gas Chromatograph with Ni ⁶³ Detector ^a	<ol style="list-style-type: none">1. Change septa daily.2. Check syringe for burrs daily.3. Change gas line dryers quarterly.4. Leak check when installing new analytical column.5. Periodically check inlet system for residue buildup.	<ol style="list-style-type: none">1. 10 1 syringes2. Inlet septa
Hewlett-Packard 5993 GC/MS ^b	<ol style="list-style-type: none">1. Replace pump oils annually.2. Change septa daily.3. Change gas line dryers quarterly.4. Replace Electron Multiplier as needed.	<ol style="list-style-type: none">1. Syringes2. Septa

^aHewlett-Packard Gas Chromatography Instrument Manual, 5840A, Hewlett-Packard, Palo Alto, CA.

^bHP 5993 GC/MS System Users Manual, Hewlett-Packard, Palo Alto, CA.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA
PRECISION, ACCURACY, REPRESENTATIVENESS,
COMPARABILITY AND COMPLETENESS

12.1 PRECISION

12.1.1 Reference Method Testing and Analytical Measurements

Precision will be determined by the analysis of replicate samples and will be expressed as the standard deviation, s , which is determined according to the following equation:

$$s = \sqrt{\frac{\sum_{i=1}^N x_i^2 - \frac{1}{N} \left(\sum_{i=1}^N x_i \right)^2}{N-1}}$$

where S = standard deviation

x_i = individual measurement result

N = number of measurements

Relative standard deviation may also be reported. If so, it will be calculated as follows:

$$RSD = 100 \left(\frac{S}{\bar{X}} \right)$$

where RSD = relative standard deviation, expressed in percent

S = standard deviation

\bar{X} = arithmetic mean of replicate measurements

12.1.2 Continuous Monitoring System

Precision will be estimated from the periodic span check data for each monitor using mid-span Manufacturer's Certified Reference Material (CRM) gases

as noted in Section 9.1. The following equations will be used to estimate precision from at least five data points:

Percent difference (d_i)

$$d_i = \frac{Y_i - X_i}{X_i} (100)$$

where: Y_i = Monitor indicated concentration from the i-th span check.

X_i = The span check reference concentration for the i-th precision check.

Mean percent difference (\bar{d}_j)

$$\bar{d}_j = \frac{1}{n} \sum_{i=1}^n d_i$$

where: n = number of valid precision checks made during the test period j .

Standard deviation of the percent difference (S_j)

$$S_j = \sqrt{\frac{1}{n-1} \sum_{i=1}^n d_i^2 - \frac{1}{n} \left(\sum_{i=1}^n d_i \right)^2}$$

Upper and lower 95 percent probability limits (UPL and LPL) will be computed as follows:

$$UPL = \bar{d}_j + 1.96 S_j$$

$$LPL = \bar{d}_j - 1.96 S_j$$

12.2 ACCURACY

12.2.1 Reference Method Tests and Analytical Measurements

Accuracy will be estimated from the analysis of "blind" QC samples whose true values are known to the Laboratory QC Coordinator. Accuracy will be expressed as percent recovery or as relative error. The formulas to calculate these values are:

$$\text{Percent Recovery} = 100 \left(\frac{\text{Measured Value}}{\text{True Value}} \right)$$
$$\text{Relative Error} = 100 \left(\frac{\text{Measured Value} - \text{True Value}}{\text{True Value}} \right)$$

Post sampling field calibration checks on the dry gas meter will be performed at the conclusion of each modified Method 5 run.

12.2.2 Continuous Monitoring System

Relative accuracy will be estimated from the period span check data for each monitor using CRM gases. The cylinder value will be used as the reference value. The following equations will be used:

The arithmetic differences will be computed as follows:

$$X_i = C_m - C_r$$

where X_i is the difference between the current concentration and previous calibration value

C_m is the monitor indicated concentration

C_r is the reference value concentration

Next, the arithmetic mean of the individual differences will be calculated:

$$\bar{X} = \frac{\sum X_i}{n}$$

where \bar{X} is the mean of the differences

X_i are the individual differences

n is the number of data points.

The confidence interval at the 95 percent confidence level will be calculated as follows:

$$CI_{95} = \frac{t_{.975}}{n(n-1)} \sqrt{n \sum (X_i^2) - \sum (X_i)^2}$$

where CI_{95} is the 95 percent confidence interval

$t_{.975}$ is a statistical "t factor"

n is the number of data points

X_i are the individual differences

The Relative Accuracy (R.A.) will be calculated from the preceding values:

$$R.A. = \frac{\bar{X} + [CI_{95}]}{C_r}$$

12.3 COMPLETENESS

Completeness will be reported as the percentage of all measurements made whose results are judged to be valid. The procedures to be used for validating data and determination of outliers are contained in Section 8.0 of this QA Plan. The following formula will be used to estimate completeness:

$$C = 100 \left(\frac{V}{T} \right)$$

where C = percent completeness

V = number of measurements judged valid

T = total number of measurements

13.0 CORRECTIVE ACTION

The acceptance limits for the sampling and analyses to be conducted in this program will be those stated in the method or defined by EPA's Project Officer. The corrective actions are likely to be immediate in nature and most often will be implemented by the analyst or Project Manager; the corrective action will usually involve recalculation, reanalysis, or repeating a sample run. GCA's ongoing corrective action policy is described here.

13.1 IMMEDIATE CORRECTIVE ACTION

Specific QC procedures and checklists are designed to help analysts detect the need for corrective action. Often the person's experience will be more valuable in alerting the operator to suspicious data or malfunctioning equipment.

If a corrective action can be taken at this point, as part of normal operating procedures, the collection of poor quality data can be avoided. Instrument and equipment malfunctions are amenable to this type of action and GCA's QC procedures include troubleshooting guides and corrective action suggestions. The actions taken should be noted in field or laboratory notebooks but no other formal documentation is required, unless further corrective action is necessary. These on-the-spot corrective actions are an everyday part of the QA/QC system.

Corrective action during the field sampling portion of a program is most often a result of equipment failure or an operator oversight and may require repeating a run. When equipment is discovered to be defective (i.e., pre- and post-sampling leak check) it is repaired or replaced and a correction factor is established as per the EPA method. If a correction factor is unacceptable the run is repeated. Operator oversight is best avoided by having field crew members audit each others work before and after a test. Every effort is made by the field team leader to ensure that all QC procedures are followed. Economically, it is preferred to repeat a run during a particular field trip rather than return at a later date.

Corrective action for the continuous monitors will involve constructing a new 3-point calibration equation. In order to minimize the time that the analyzer is offline, the span gases will be sampled intermittently (e.g., zero, flue gas, mid span, flue gas, high span).

Corrective action for analytical work would include recalibration of instruments, reanalysis of known QC samples and, if necessary, of actual field samples.

If the problem is not solved in this way, more formalized long-term corrective action may be necessary.

13.2 LONG-TERM CORRECTIVE ACTION

The need for this action may be identified by standard QC procedures, control charts, performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into the long-term category. GCA uses a system to ensure that the condition is reported to a person responsible for correcting it who is part of the closed-loop action and follow-up plan. It is patterned after the system described in Reference 10.

The essential steps in the closed-loop corrective action system are:

- Identify and define the problem.
- Assign responsibility for investigating the problem.
- Investigate and determine the cause of the problem.
- Determine a corrective action to eliminate the problem.
- Assign and accept responsibility for implementing the corrective action.
- Establish effectiveness of the corrective action and implement it.
- Verify that the corrective action has eliminated the problem.

Documentation of the problem is important to the system. A Corrective Action Request Form (shown in Figure 13-1) is filled out by the person finding the quality problem. This form identifies the problem, possible causes and

the person responsible for action on the problem. The responsible person may be an analyst, field team leader, department QC coordinator or the QA Manager. If no person is identified as responsible for action, the QA Manager investigates the situation and determines who is responsible in each case.

The Corrective Action Request Form includes a description of the corrective action planned and the date it was taken, and space for follow-up. The QA Manager checks to be sure that initial action has been taken and appears effective and, at an appropriate later date, checks again to see if the problem has been fully solved. The QA Manager receives a copy of all Corrective Action Forms and then enters them in the Corrective Action Log. This permanent record aids the QA Manager in follow-up and makes any quality problems visible to management; the log may also prove valuable in listing a similar problem and its solution.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

14.1 INTERNAL REPORTS

The Analytical Laboratory QC Coordinator and the Environmental Measurements Department QC Coordinator prepare written monthly reports on QC activities for their Department Manager and the Division QA Manager. These reports detail the results of quality control procedures, problems encountered and any corrective action which may have been required.

All Corrective Action Forms are submitted to the QA Manager for initial approval of the corrective action planned and a copy is provided to the department manager. All system audit reports are provided to the project manager, department manager and the Technology Division General Manager.

14.2 REPORTS TO EPA

Each data transmittal will contain a summary of QC activities; this summary will include:

- Estimates of precision, accuracy and completeness of reported data
- Quality problems found
- Corrective actions taken

The final report will include a section summarizing QA/QC activities during the program. The Laboratory and Environmental Measurements QC Coordinators and the Division QA Manager will participate in preparing this section.

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APPENDIX A
FIELD DATA SHEETS

Page _____ of _____

[illegible]

2/81

CLIENT _____

GCA WORK ORDER NO. _____

DATE: _____

PLANT _____

SAMPLING LOCATION _____

METER BOX NO. _____ METER BOX ΔH@ _____

MOISTURE VOL. % _____ BAR. PRESSURE (PB)(PM) _____ in Hg

STATIC PRESSURE SAMPLING POINT (PST) _____ in. H₂O x $\frac{1}{13.6}$ = _____ in. Hg

PRESSURE STACK (PS) PB±(PST) = _____ = _____ in. Hg

PS/PM = _____ = _____ PITOT TUBE NO. _____

$$C_p = \text{---}; (C_p/0.85)^2 = (\text{---})^2 = \text{---} C_{pc}; C_c = C \times c_{pc}$$

Δp LOW _____; Δp AVERAGE _____; Δp HIGH _____

NOZZLE DIAMETER _____ in. ; TS min _____ TS avg _____ TS high _____

[illegible]

K FACTOR REFERENCE
ON Δp SCALE

SKETCH

PROBE HEATER SETTING _____

* FIELDS FOR NONPARTICULATE RUN

FACTOR

TOTAL

COMMENT

(REVISED 8/31/79)

GCA/TECHNOLOGY DIVISION
SOURCE PARTICULATE SAMPLING
TRAIN ASSEMBLY, RECOVERY AND ANALYTICAL REPORT SHEET

Appendix A
Revision 0
August 3, 1982
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Run Date: _____ Client: _____
Run No.: _____ W. O. No.: _____
Sample Box No.: _____ Plant: _____
Operator: _____ Sampling Location: _____

FRONT HALF

Laboratory Results

Nozzle and Probe (Cyclone Bypass)-Acetone Wash, Lab No.: _____ Residue _____ mg
Cyclone and Flask-Acetone Wash Lab No.: _____ Residue _____ mg

Thimble No.	Lab No.	Weight Results
_____	_____	_____ mg
_____	_____	_____ mg
_____	_____	_____ mg
_____	_____	_____ mg

Thimble particulate weight _____ mg

Filter No.	Lab No.	Weight Results
_____	_____	_____ mg
_____	_____	_____ mg
_____	_____	_____ mg
_____	_____	_____ mg

Filter particulate weight _____ mg

FRONT HALF Sub Total _____ mg

BACK HALF

Impinger WATER and Water Wash of Impingers
Connectors and Back Half of Filter Holder
Lab No.: _____

Collected on 0.22µ Filter _____ mg
Chloroform-ether Extract _____ mg
Aqueous Residue _____ mg

ACETONE WASH of
Impinger, Connectors and Back Half of
Filter Holder
Lab No.: _____

Residue _____ mg
BACK HALF Sub Total _____ mg

TOTAL TRAIN

TOTAL WEIGHT (Front & Back) _____ mg

MOISTURE

Impingers: _____

Final Volume Total _____
Initial Volume Total _____
Net Volume _____

Silica Gel
Weight after test: _____
Weight before test: _____
Net Weight: _____
Container No.: 1. _____ 2. _____ 3. _____ 4. _____
TOTAL NET WEIGHT-Silica Gel _____ gm
NET VOLUME-Impingers _____ ml
TOTAL MOISTURE _____ gm

Comments: _____

LAB: DATE RECEIVED _____
DATE REPORTED _____

Train Assembled by: _____
Sample Recovered by: _____
Sample Analyzed by: _____

PARTICULATE ANALYSIS

Lab No. _____ WO No. _____

Client _____ Date Received _____

Description _____
_____A. SAMPLE VOLUME

_____ mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
_____	_____ g
_____	_____ g
_____	_____ g
_____	_____ g

CONTAINER NO.

0.22/0.45

μ

FILTER NO.
_____E. GROSS WEIGHTS

<u>RH/°F</u>	<u>Date/Time</u>		<u>RH/°F</u>	<u>Date/Time</u>	
____/____	____/____	(1) _____ g	____/____	____/____	(4) _____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight _____ g

Total Tare Weight - _____ g

Residue Weight _____ g

Blank Weight - _____ g

↓

_____ g

E. NET WEIGHTRemarks: _____

Analyst _____

Leak checks: initial _____
 final _____

APPENDIX B
FIELD DATA REDUCTION

Facility _____
Source _____
Run _____

Job No. _____
Date _____
Calc/Review _____

SAMPLE CALCULATIONS

Particulate Isokinetic Sampling

I. Calculations for stack volume and Isokinetic Ratio

Time	Dry Gas Meter ft ³	Pitot ΔP, in. H ₂ O	Orifice ΔH, in. H ₂ O	Dry Gas Temp °F In Out	Stack Static Pressure in. H ₂ O	Stack Temp °F
T	VM	ΔP	PM	TMI TMO	PST	TS

1. DN - Nozzle Diameter, inches _____ in.

2. PB = Barometric Pressure, inches Hg _____ in. Hg

3. TT = Net Sampling Time, minutes _____ min.

4. VM = VM final - VM initial = Sample Gas Volume, ft³ _____ ft³

4A.VML = Use only if any final or intermediate leak check rate
is over 0.02 cfm

LI = Leak rate after any given sampling period, cfm

TLI = Total time of sampling period in which leak occurred, min.

VML = VM - [(L1 - 0.02) TL1 + (L2 - 0.02) TL2 + (L3 - 0.02) TL3 +
L4 + 0.02) TL4]

= () - [(- 0.02)() + (- 0.02)() + (- 0.02)
() + (- 0.02)()]

= () - [() + () + () + ()]

= () - () = _____ ft³

5. TM = Average Dry Gas Temperature at Meter, °F

TM = $\frac{\text{Avg. TMI} + \text{Avg. TMO}}{2}$ = _____ °F

6. PM = Average Orifice Pressure Drop, inches H₂O

PM = Avg. Δ H = _____ ÷ 13.6 = _____ in.Hg

7. Volume of dry gas sampled at standard conditions, ^a dscf

VMSTD = $\frac{528 (Y)(VM)(PB + \frac{PM}{13.6})}{29.92 (TM + 460)}$ Y = dry gas meter
calibration factor _____
= $\frac{528 () () ()}{29.92 ()}$ = _____ ft³

Job No. _____
Run No. _____

8. VW = Total Water Collected = gm H₂O Silica gel + ml Imp. H₂O = ml
() + () = _____

9. Volume of water vapor at standard conditions, scf

VW gas = 0.04715 × VW = scf = 0.04715 () = _____ ft³

10. Percent moisture in stack gas

$$\% M = \frac{100 \times \text{VW gas}}{\text{VMSTD} + \text{VW gas}} = \frac{100 ()}{() + ()} = \frac{()}{()} = \text{_____}\%$$

11. Mole fraction of dry gas

$$\text{MD} = \frac{100 - \%M}{100} = \frac{100 - ()}{100} = \text{_____}$$

12. Molecular weight of dry stack gas

$$\begin{aligned} \text{MWD} &= (\% \text{CO}_2 \times \frac{44}{100}) + (\% \text{O}_2 \times \frac{32}{100}) + [(\% \text{CO} + \% \text{N}_2) \times \frac{28}{100}] \\ &= (\times 0.44) + (\times 0.32) + (\times 0.28) \\ &= () + () + () = \text{_____ lb/lb mole dry} \end{aligned}$$

$$\begin{aligned} 12\text{A. } \% \text{EA} = \% \text{ Excess Air} &= \frac{[(\% \text{O}_2 - 0.5 (\% \text{CO})) \times 100]}{[(0.264 (\% \text{N}_2)) - (\% \text{O}_2) + 0.5 (\% \text{CO})]} \\ &= \frac{() \times 100}{[(0.264 ()) - () + 0.5 ()]} \\ &= \frac{() - 100}{() - () + ()} = \text{_____}\% \end{aligned}$$

13. Molecular weight of wet stack gas

$$\begin{aligned} \text{MW} &= \text{MWD} \times \text{MD} + 18 (1 - \text{MD}) \\ &= () () + 18 (1 -) \\ &= () + () = \text{_____ lb/lb mole wet} \end{aligned}$$

14. AS = Stack Area, square inches

$$\text{Circular, } = \left(\frac{\text{Stack diameter}}{2} \right)^2 \pi = \left(\frac{ }{2} \right)^2 \pi = \text{_____ sq. in.}$$

$$\text{Rectangular, } = \text{Length} \times \text{width} = () () = \text{_____ sq. in.}$$

15. PS = Stack Pressure, absolute, inches Hg = PB ± AV PST

PST = Stack static pressure

Job No. _____
Run No. _____

$$\text{PST in. Hg} = \frac{\text{PST in. H}_2\text{O}}{13.6} = \frac{\quad}{13.6} = \quad \text{in. Hg}$$

$$\text{PS} = \text{PB} \pm \text{Avg. PST} = (\quad) (\quad) = \quad \text{in. Hg}$$

$$16. \text{ TS} = \text{Average Stack Temperature, } \quad ^\circ\text{F} + 460 = \quad ^\circ\text{R}$$

$$\text{TS} = \text{Average TS} \quad \sqrt{\text{TS}_{\text{AV}} + 460} = \quad$$

$$17. \text{ SDE}_{\text{AV}} = (\sqrt{\Delta P})_{\text{AV}} \times \sqrt{\text{TS}_{\text{AV}} + 460} = (\quad) (\quad) = \quad$$

$$18. \text{ Stack gas velocity at stack conditions, afpm}$$

$$\text{VS} = 5130^{(e)} \times \text{Cp} \times \text{Avg. (SDE)} \times \left[\frac{1}{\text{PS} \times \text{MW}} \right]^{\frac{1}{2}} = \text{afpm} \quad \text{Cp} = \text{pitot tube coefficient}$$

$$= 5130 \times (\quad) \times (\quad) \times \left[\frac{1}{(\quad)(\quad)} \right]^{\frac{1}{2}} = \quad \text{afpm}$$

$$19. \text{ Stack gas volumetric flow rate at standard conditions, }^c \text{ dscfm}$$

$$Q_s = \frac{528 \times \text{VS} \times \text{AS} \times \text{MD} \times \text{PS}}{(29.92)(144)(\text{TS} + 460)} = \text{dscfm}$$

$$= \frac{528 (\quad) \times (\quad) \times (\quad) \times (\quad)}{29.92 \times 144 (\quad)} = \quad \text{dscfm}$$

$$20. \text{ Stack gas volumetric flow rate at stack conditions, acfm}^d$$

$$Q_a = \frac{29.92 \times Q_s (\text{TS} + 460)}{(528) (\text{PS}) (\text{MD})} = \text{acfm}$$

$$= \frac{29.92 (\quad) (\quad)}{528 (\quad) (\quad)} = \quad \text{acfm}$$

$$21. \text{ Percent isokinetics}$$

$$\% I = \frac{1,039^{(f)} \times (\text{TS} + 460) \times \text{VMSTD}}{\text{VS} \times \text{TT} \times \text{PS} \times \text{MD} \times (\text{DN})^2}$$

^a Dry standard cubic feet at 68°F (528R) and 29.92 in. Hg.

^b Standard conditions at 68°F (528R) and 29.92 in. Hg.

^c Dry standard cubic feet per minute at 68°F (528) and 29.92 in. Hg.

^d Actual cubic feet per minute

$$^e 5130 = 85.5 \frac{\text{ft}}{\text{sec}} \left[\frac{(\text{lb/lb mole})(\text{in. Hg})}{(^{\circ}\text{R})(\text{in. H}_2\text{O})} \right]^{\frac{1}{2}} \times 60 \text{ sec/min}$$

$$^f 1039 = \frac{29.92 \text{ in. Hg}}{528 \text{ DegR}} \times \frac{144 \text{ in.}^2}{\text{ft}^2} \times \frac{4}{\pi} \times 100$$

Job No. _____
Run No. _____

$$= \frac{1,039 \times () \times ()}{() \times () \times () \times () \times ()^2}$$

$$= \text{_____} \%$$

II. Calculations for grain loading and emission rates

22. Particulate, gr/dscf

$$\text{gr/dscf} = 0.0154 \times \frac{\text{mg}}{\text{VMSTD}} = \frac{0.0154 ()}{()} = \text{_____ gr/dscf}$$

23. Particulate at stack conditions, gr/acf

$$\begin{aligned} \text{gr/acf} &= \frac{528 \times \text{gr/dscf} \times \text{PS} \times \text{MD}}{29.92 (\text{TS} + 460)} \\ &= \frac{528 () \times () \times ()}{29.92 ()} = \text{_____ gr/acf} \end{aligned}$$

24. Particulate, lb/hr conc. method

$$\begin{aligned} \text{lb/hr} &= \frac{60 \text{ min/hr} \times \text{gr/dscf} \times \text{QS}}{7000 \text{ gr/lb}} = \frac{60 \text{ min/hr}}{7000 \text{ gr/lb}} \times () \times () \\ &= \text{_____ lb/hr} \end{aligned}$$

25. Particulate lb/hr area method = $0.132 \times \frac{\text{gms particulate} \times \text{AS}}{\pi \left(\frac{\text{DN}}{2}\right)^2 \times \text{TT}}$

$$= \frac{0.132 \times () \times ()}{\pi \left(\frac{ }{2}\right)^2 \times ()} = \text{_____ lb/hr}$$

$$26. \frac{\text{lb/hr area} \times 100}{\text{lb/hr conc.}} = \frac{()}{()} \times 100 = \text{_____} \% \text{ I}$$

27. Particulate combustion lb/10⁶ Btu heat input method

$$\text{lb/hr} = \text{avg. of area and conc. method} = \text{_____}$$

$$10^6 \text{ Btu from fuel flow, steam generation or heat rate} = \text{_____}$$

$$\frac{\text{lb/hr}}{10^6 \text{ Btu hr}} = \frac{()}{()} = \text{_____ lb/10}^6 \text{ Btu}$$

28. lb/10⁶ Btu F Factor method =

$$\begin{aligned} \frac{\text{gr/dscf}}{7000} \times \text{F} \times \frac{20.9}{(20.9 - \% \text{ O}_2)} &= \frac{\text{_____}}{7000} \times () \times \frac{20.9}{[20.9 - ()]} \\ &= \frac{\text{_____}}{7000} \times () \times \frac{(20.9)}{()} = \\ &= \text{_____ lb/10}^6 \text{ Btu} \end{aligned}$$

Job No. _____
Run No. _____

29. Density of stack gas

$$\begin{aligned} \text{a. Wet at stack condition} &= \text{MW lb/lb mol} / \left[21.85 \times \left(\frac{\text{TS} + 460}{\text{PS}} \right) \right] \\ &= (\quad) / \left[21.85 \times \left(\frac{\quad}{\quad} \right) \right] = (\quad) / (\quad) = \text{lb/lb} \\ &\hspace{15em} \text{mole wet} \end{aligned}$$

$$\text{b. Dry at } 68^{\circ}\text{F (528R) and 29.92 in. Hg} = \text{MWD}/385.6$$

$$= (\quad) / 385.6 = \text{lb/lb} \\ \text{mole dry}$$

30. Exhaust gas flow rate

$$\text{a. lb/hr dry} = \text{QS} \times 60 \times \text{density dry}$$

$$\text{FRS} = (\quad) \times 60 \times (\quad) = \text{lb/hr}$$

$$\text{b. lb/hr wet} = \text{QA} \times 60 \times \text{density wet}$$

$$\text{FRA} = (\quad) \times 60 \times (\quad) = \text{lb/hr}$$

$$31. \text{ gr/dscf at 12\% CO}_2 = \text{gr/dscf} \times \frac{12}{\% \text{ CO}_2}$$

$$= (\quad) \times \left(\frac{12}{\quad} \right) = \text{gr/dscf}$$

$$32. \text{ gr/dscf at 50\% excess air} = \frac{100 + \text{EA}}{150} \times \text{gr/dscf}$$

$$= \left(\frac{\quad}{150} + 100 \right) \times (\quad) = \text{gr/dscf}$$

$$33. \text{ lb pollutant/1000 lb flue gas at 12\% CO}_2$$

$$\text{wet or dry} = \frac{\text{lb pollutant/hr}}{\text{FRA or FRS}} \times \frac{12}{\% \text{ CO}_2} \times 1000$$

$$= \left(\frac{\quad}{\quad} \right) \left(\frac{12}{\quad} \right) \times 1000$$

$$= \text{lb/1000 lb}$$

APPENDIX C
SAMPLE CALCULATIONS

DETERMINATION OF SCRUBBER EFFLUENT FLOW RATE

The flow rate of the scrubber effluent was calculated by doing a moisture balance over the system in accordance with the equations presented below. The equation input parameters and results are presented in Table C-1.

$$E_R = M_s + M_f + M_c + F_r - M_{stk}$$

where E_R = scrubber effluent flow rate, gal/min
 M_s = moisture flow rate into incinerator due to sludge, gal/min
 M_f = moisture flow rate into incinerator due to fuel and sludge conversion, gal/min
 M_c = moisture flow rate into incinerator due to combustion air, gal/min
 F_R = scrubber and precooler feed flow rate, gal/min
 M_{stk} = moisture flow rate out of incinerator in flue gas, gal/min

$$M_s = S_{RW} \times f_w \times 0.1198 \text{ gal H}_2\text{O/lb H}_2\text{O}$$

where S_{RW} = sludge feed rate (wet basis), lb/min
 f_w = water fraction = 1 - solids fraction

$$M_f = (G_R C_{wg} + S_{Rd} F_v C_{ws}) (0.1198 \text{ gal H}_2\text{O/lb H}_2\text{O})$$

$$M_f = (G_R \times 0.099 + S_{Rd} \times 0.59) (0.1198)$$

where G_R = natural gas firing rate, ft³/min
 C_{wg} = water wt/volume of natural gas burned (0.099 lb H₂O/ft³ gas)
 S_{Rd} = sludge feed rate (dry basis), lb/min
 f_v = volatile fraction (0.80)*
 C_{ws} = water weight/weight of volatile (0.74 lb H₂O/lb volatile)*

*Design parameter

TABLE C-1. DETERMINATION OF SCRUBBER EFFLUENT FLOW RATE

Run No.	Date	Time	S_{rw} lb/min	f_w	M_s gal/min	G_r ft ² /min	S_{rd} lb/min	M_f gal/min	M_c gal/min	F_r gal/min	Q_{dstp} ft ³ /min	f_{dg}	M_{stk} gal/min	Scrubber effluent flow rate, gal/min
2	2/1/84	1307 to 1636	40.9	0.78	3.82	47.84	9.00	1.20	1.36	365	1883	0.99	0.11	371
3	2/6/84	1508 to 1826	42.2	0.78	3.94	25.25	9.28	0.96	1.19	365	1665	0.99	0.09	371
4	2/7/84	1019 to 1342	32.4	0.78	3.03	24.63	7.13	0.80	0.96	365	1665	0.99	0.09	370

$$M_c = C_A (\rho_a G_R A_g + S_{Rd} f_v A_v) (0.1198 \text{ gal H}_2\text{O/lb H}_2\text{O})$$

$$M_c = 0.0096 (0.920 \times G_R + S_{Rd} \times 10.9)$$

where C_A = water weight/weight of combustion air (0.08 lb H₂O/lb dry air)*

A_g = air required for gas combustion at 20 percent excess air
(12,432 ft³ air/ft³ gas)**

A_v = air required for volatiles combustion at 75 percent excess air
(13.60 lb air/lb volatile)

ρ_a = air density at 70°F (0.074 lb/ft³)

$$F_R = F_p + F_s$$

where F_p = precooler feed flow = 42 gpm

F_s = scrubber feed design flow = 340 gpm

$M_{stk} = (Q_{dstp}/f_{dg} - Q_{dstp}) (0.005567 \text{ gal H}_2\text{O/ft}^3 \text{ H}_2\text{O vapor})$

where Q_{dstp} = dry volumetric flue gas flow rate at STP (70°F + 29.92 in. Hg),

f_{dg} = dry gas fraction

*From psychromatic chart assuming 70°F and 50 percent RH

**Design parameter

Facility _____
 Source _____
 Run _____

Job No. _____
 Date _____
 Calc./Review _____

SAMPLE CALCULATIONS

Particulate Isokinetic Sampling

I. Calculations for stack volume and Isokinetic Ratio

Time	Dry Gas Meter ft ³	Pitot ΔP , in. H ₂ O	Orifice ΔH , in. H ₂ O	Dry Gas Temp °F In Out	Stack Static Pressure in. H ₂ O	Stack Temp °F
T	VM	ΔP	PM	TMI TMO	PST	TS

1. DN = Nozzle Diameter, inches _____ in.
2. PB = Barometric Pressure, inches Hg _____ in. Hg
3. TT = Net Sampling Time, minutes _____ min.
4. VM = VM final - VM initial = Sample Gas Volume, ft³ _____ ft³
- 4A. VML = Use only if any final or intermediate leak check rate is over 0.02 cfm

LI = Leak rate after any given sampling period, cfm

TLI = Total time of sampling period in which leak occurred, min.

$$VML = VM - [(L1 - 0.02) TL1 + (L2 - 0.02) TL2 + (L3 - 0.02) TL3 + L4 + 0.02) TL4]$$

$$= (\quad) - [(\quad - 0.02)(\quad) + (\quad - 0.02)(\quad) + (\quad - 0.02)(\quad) + (\quad - 0.02)(\quad)]$$

$$= (\quad) - [(\quad) + (\quad) + (\quad) + (\quad)]$$

$$= (\quad) - (\quad) = \text{_____ ft}^3$$

5. TM = Average Dry Gas Temperature at Meter, °F

$$TM = \frac{\text{Avg. TMI} + \text{Avg. TMO}}{2} = \text{_____ } ^\circ\text{F}$$

6. PM = Average Orifice Pressure Drop, inches H₂O

$$PM = \text{Avg. } \Delta H = \text{_____} \div 13.6 = \text{_____ in. Hg}$$

7. Volume of dry gas sampled at standard conditions, ^a dscf

$$VMSTD = \frac{528 (Y)(VM)(PB + \frac{PM}{13.6})}{29.92 (TM + 460)} \quad Y = \text{dry gas meter calibration factor}$$

$$= \frac{528 (\quad)(\quad)(\quad)}{29.92 (\quad)} = \text{_____ ft}^3$$

Job No. _____

Run No. _____

8. VW = Total Water Collected = gm H₂O Silica gel + ml Imp. H₂O = ml
 () + () = _____

9. Volume of water vapor at standard conditions, scf

VW gas = 0.04715 × VW = scf = 0.04715 () = _____ ft³

10. Percent moisture in stack gas

$$\% M = \frac{100 \times VW_{\text{gas}}}{VMSTD + VW_{\text{gas}}} = \frac{100 ()}{() + ()} = \frac{()}{()} = \text{_____}\%$$

11. Mole fraction of dry gas

$$MD = \frac{100 - \%M}{100} = \frac{100 - ()}{100} = \text{_____}$$

12. Molecular weight of dry stack gas

$$\begin{aligned} MWD &= (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + [(\%CO + \%N_2) \times \frac{28}{100}] \\ &= (\times 0.44) + (\times 0.32) + (\times 0.28) \\ &= () + () + () = \text{_____ lb/lb mole dry} \end{aligned}$$

$$\begin{aligned} 12A. \%EA = \% \text{ Excess Air} &= \frac{[(\% O_2 - 0.5 (\%CO))] \times 100}{[(0.264 (\%N_2))] - (\% O_2) + 0.5 (\%CO)} \\ &= \frac{() \times 100}{[(0.264 ())] - () + 0.5 ()} \\ &= \frac{() \times 100}{() - () + ()} = \text{_____}\% \end{aligned}$$

13. Molecular weight of wet stack gas

$$\begin{aligned} MW &= MWD \times MD + 18 (1 - MD) \\ &= () () + 18 (1 -) \\ &= () + () = \text{_____ lb/lb mole wet} \end{aligned}$$

14. AS = Stack Area, square inches

$$\text{Circular, } = \left(\frac{\text{Stack diameter}}{2} \right)^2 \pi = \left(\frac{ }{2} \right)^2 \pi = \text{_____ sq. in.}$$

$$\text{Rectangular, } = \text{Length} \times \text{width} = () () = \text{_____ sq. in.}$$

15. PS = Stack Pressure, absolute, inches Hg = PB ± AV PST

PST = Stack static pressure

Job No. _____
Run No. _____

$$\text{PST in. Hg} = \frac{\text{PST in. H}_2\text{O}}{13.6} = \frac{\quad}{13.6} = \quad \text{in. Hg}$$

$$\text{PS} = \text{PB} \pm \text{Avg. PST} = (\quad) (\quad) = \quad \text{in. Hg}$$

$$16. \text{ TS} = \text{Average Stack Temperature, } \quad ^\circ\text{F} + 460 = \quad ^\circ\text{R}$$

$$\text{TS} = \text{Average TS} \quad \sqrt{\text{TS}_{\text{AV}} + 460} = \quad$$

$$17. \text{ SDE}_{\text{AV}} = (\sqrt{\Delta P})_{\text{AV}} \times \sqrt{\text{TS}_{\text{AV}} + 460} = (\quad) (\quad) = \quad$$

$$18. \text{ Stack gas velocity at stack conditions, afpm}$$

$$\text{VS} = 5130^{(e)} \times \text{Cp} \times \text{Avg. (SDE)} \times \left[\frac{1}{\text{PS} \times \text{MW}} \right]^{\frac{1}{2}} = \text{afpm} \quad \text{Cp} = \text{pitot tube coefficient}$$

$$= 5130 \times (\quad) \times (\quad) \times \left[\frac{1}{(\quad)(\quad)} \right]^{\frac{1}{2}} = \quad \text{afpm}$$

$$19. \text{ Stack gas volumetric flow rate at standard conditions, } ^c \text{ dscfm}$$

$$Q_s = \frac{528 \times \text{VS} \times \text{AS} \times \text{MD} \times \text{PS}}{(29.92)(144)(\text{TS} + 460)} = \text{dscfm}$$

$$= \frac{528 (\quad) \times (\quad) \times (\quad) \times (\quad)}{29.92 \times 144 (\quad)} = \quad \text{dscfm}$$

$$20. \text{ Stack gas volumetric flow rate at stack conditions, acfm}^d$$

$$Q_a = \frac{29.92 \times Q_s (\text{TS} + 460)}{(528) (\text{PS}) (\text{MD})} = \text{acfm}$$

$$= \frac{29.92 (\quad) (\quad)}{528 (\quad) (\quad)} = \quad \text{acfm}$$

$$21. \text{ Percent isokinetics}$$

$$\% I = \frac{1,039^{(f)} \times (\text{TS} + 460) \times \text{VMSTD}}{\text{VS} \times \text{TT} \times \text{PS} \times \text{MD} \times (\text{DN})^2}$$

^a Dry standard cubic feet at 68°F (528R) and 29.92 in. Hg.

^b Standard conditions at 68°F (528R) and 29.92 in. Hg.

^c Dry standard cubic feet per minute at 68°F (528) and 29.92 in. Hg.

^d Actual cubic feet per minute

$$^e 5130 = 85.5 \frac{\text{ft}}{\text{sec}} \left[\frac{(\text{lb/lb mole})(\text{in. Hg})}{(^{\circ}\text{R})(\text{in. H}_2\text{O})} \right]^{\frac{1}{2}} \times 60 \text{ sec/min}$$

$$^f 1039 = \frac{29.92 \text{ in. Hg}}{528 \text{ DegR}} \times \frac{144 \text{ in.}^2}{\text{ft}^2} \times \frac{4}{\pi} \times 100$$

Job No. _____
Run No. _____

$$= \frac{1,039 \times () \times ()}{() \times () \times () \times () \times ()^2}$$

$$= \text{_____} \%$$

II. Calculations for grain loading and emission rates

22. Particulate, gr/dscf

$$\text{gr/dscf} = 0.0154 \times \frac{\text{mg}}{\text{VMSTD}} = \frac{0.0154 ()}{()} = \text{_____ gr/dscf}$$

23. Particulate at stack conditions, gr/acf

$$\text{gr/acf} = \frac{528 \times \text{gr/dscf} \times \text{PS} \times \text{MD}}{29.92 (\text{TS} + 460)}$$

$$= \frac{528 () \times () \times ()}{29.92 ()} = \text{_____ gr/acf}$$

24. Particulate, lb/hr conc. method

$$\text{lb/hr} = \frac{60 \text{ min/hr} \times \text{gr/dscf} \times \text{QS}}{7000 \text{ gr/lb}} = \frac{60 \text{ min/hr}}{7000 \text{ gr/lb}} \times () \times ()$$

$$= \text{_____ lb/hr}$$

25. Particulate lb/hr area method = $0.132 \times \frac{\text{gms particulate} \times \text{AS}}{\pi \left(\frac{\text{DN}}{2} \right)^2 \times \text{TT}}$

$$= \frac{0.132 \times () \times ()}{\pi \left(\frac{ }{2} \right)^2 \times ()} = \text{_____ lb/hr}$$

$$26. \frac{\text{lb/hr area} \times 100}{\text{lb/hr conc.}} = \frac{()}{()} \times 100 = \text{_____} \% \text{ I}$$

27. Particulate combustion lb/10⁶ Btu heat input method

$$\text{lb/hr} = \text{avg. of area and conc. method} = \text{_____}$$

$$10^6 \text{ Btu from fuel flow, steam generation or heat rate} = \text{_____}$$

$$\frac{\text{lb/hr}}{10^6 \text{ Btu hr}} = \frac{()}{()} = \text{_____ lb/10}^6 \text{ Btu}$$

28. lb/10⁶ Btu F Factor method =

$$\frac{\text{gr/dscf}}{7000} \times F \times \frac{20.9}{(20.9 - \% \text{ O}_2)} = \frac{\text{_____}}{7000} \times () \times \frac{20.9}{[20.9 - ()]}$$

$$= \frac{\text{_____}}{7000} \times () \times \frac{(20.9)}{()} =$$

$$= \text{_____ lb/10}^6 \text{ Btu}$$

Job No. _____
Run No. _____

29. Density of stack gas

$$\begin{aligned} \text{a. Wet at stack condition} &= \text{MW lb/lb mol} / \left[21.85 \times \left(\frac{\text{TS} + 460}{\text{PS}} \right) \right] \\ &= (\quad) / \left[21.85 \times \left(\frac{\quad}{\quad} \right) \right] = (\quad) / (\quad) = \text{_____ lb/lb} \\ &\hspace{15em} \text{mole wet} \end{aligned}$$

b. Dry at 68°F (528R) and 29.92 in. Hg = MWD/385.6

$$= (\quad) / 385.6 = \text{_____ lb/lb} \\ \text{mole dry}$$

30. Exhaust gas flow rate

a. lb/hr dry = QS × 60 × density dry

$$\text{FRS} = (\quad) \times 60 \times (\quad) = \text{_____ lb/hr}$$

b. lb/hr wet = QA × 60 × density wet

$$\text{FRA} = (\quad) \times 60 \times (\quad) = \text{_____ lb/hr}$$

31. gr/dscf at 12% CO₂ = gr/dscf × $\frac{12}{\% \text{ CO}_2}$

$$= (\quad) \times \left(\frac{12}{\quad} \right) = \text{_____ gr/dscf}$$

32. gr/dscf at 50% excess air = $\frac{100 + \text{EA}}{150} \times \text{gr/dscf}$

$$= \frac{(\quad) + 100}{150} \times (\quad) = \text{_____ gr/dscf}$$

33. lb pollutant/1000 lb flue gas at 12% CO₂

wet or dry $= \frac{\text{lb pollutant/hr}}{\text{FRA or FRS}} \times \frac{12}{\% \text{ CO}_2} \times 1000$

$$= \frac{(\quad)}{(\quad)} \left(\frac{12}{\quad} \right) \times 1000$$

$$= \text{_____ lb/1000 lb}$$

SOURCE _____

CALCULATED BY _____

RUN _____

DATE _____

F FACTOR CALCULATION (530R)

% H = _____ % C = _____ % S = _____ % N = _____

% O = _____ GCV = _____ Btu/lb

$$F = \frac{10^6 [3.64 (\%H) + 1.53 (\%C) + 0.57 (\%S) + 0.14 (\%N) - 0.46 (\%O)]}{GCV}$$

$$F = \frac{10^6 [3.64 () + 1.53 () + 0.57 () + 0.14 () - 0.46 ()]}{GCV}$$

$$F = \frac{10^6 [() + () + () + () - ()]}{GCV}$$

$$F = 10^6 []$$

$$F = \text{dscf}/10^6 \text{ Btu}$$

SOURCE W Bedford Sludge Incinerator

CALCULATED BY _____

RUN _____

DATE _____

F FACTOR CALCULATION (530R)

% H = 5.42 % C = 39.2 % S = 0.44 % N = 1.58

% O = 31.4 GCV = 6929 Btu/lb

$$F = \frac{10^6 [3.64 (\%H) + 1.53 (\%C) + 0.57 (\%S) + 0.14 (\%N) - 0.46 (\%O)]}{GCV}$$

$$F = \frac{10^6 [3.64(5.42) + 1.53(39.2) + 0.57(0.44) + 0.14(1.58) - 0.46(31.4)]}{GCV}$$

$$F = \frac{10^6 [(19.73) + (59.98) + (0.2508) + (0.2212) - (14.44)]}{GCV}$$

$$F = \frac{10^6 [65.742]}{6929}$$

$$F = 9487.9 \quad \text{dscf}/10^6 \text{ Btu}$$



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SHEET 1 OF 1

BY M. White

DATE 7/6/84

CH'K. BY O'BRIEN

DATE CH'K. 7/6/84

B'K. CH'K. BY

JOB NO.

PROJECT New Bedford Sludge Incinerator

SUBJECT Incinerator feed rate

Run 2

$$\frac{10,000 \text{ ft}^3 \text{ natural gas}}{182 \text{ minutes}} * \frac{1060 \text{ BTU}}{\text{ft}^3 \text{ nat gas}} * \frac{8710 \text{ dscf}}{10^6 \text{ BTU}} = \frac{507.3 \text{ dscf}}{\text{min}} \text{ generated by nat gas}$$

$$\frac{10^6 \text{ BTU}}{9488 \text{ dscf}} * \frac{\text{Lb dry sludge}}{6929 \text{ BTU}} * \frac{60 \text{ min}}{\text{hr}} * \left[\frac{(1333.4 - 507.3) \text{ dscf}}{\text{min}} \right] = \frac{1255.9 \text{ Lb dry sludge}}{\text{hr}}$$

Run 3

$$\frac{2000 \text{ ft}^3 \text{ nat gas}}{182 \text{ min}} * \frac{1060 \text{ BTU}}{\text{ft}^3 \text{ nat gas}} * \frac{8710 \text{ dscf}}{10^6 \text{ BTU}} = \frac{101.5 \text{ dscf}}{\text{min}} \text{ generated by nat. gas}$$

$$\frac{10^6 \text{ BTU}}{9488 \text{ dscf}} * \frac{\text{Lb dry sludge}}{6929 \text{ BTU}} * \frac{60 \text{ min}}{\text{hr}} * \left[\frac{(1665.1 - 101.5) \text{ dscf}}{\text{min}} \right] = \frac{1427.0 \text{ Lb dry sludge}}{\text{hr}}$$

Run 4

$$\frac{2000 \text{ ft}^3 \text{ nat gas}}{142 \text{ min}} * \frac{1060 \text{ BTU}}{\text{ft}^3 \text{ nat gas}} * \frac{8710 \text{ dscf}}{10^6 \text{ BTU}} = \frac{130.0 \text{ dscf}}{\text{min}} \text{ generated by nat. gas}$$

$$\frac{10^6 \text{ BTU}}{9488 \text{ dscf}} * \frac{\text{Lb dry sludge}}{6929 \text{ BTU}} * \frac{60 \text{ min}}{\text{hr}} * \left[\frac{(1665.2 - 130.0) \text{ dscf}}{\text{min}} \right] = \frac{1401.1 \text{ Lb dry sludge}}{\text{hr}}$$

1401.1

JOB NO. _____

PROJECT New Bedford Sewage Sludge Incinerator

SUBJECT Incubator feed rate calculations

Run 2

$$\frac{10^6 \text{ BTU}}{4488 \text{ dscf}} * \frac{\text{dry lb of sludge}}{6929 \text{ BTU}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1883.4 \text{ dscf}}{\text{min}} = \frac{1713.9 \text{ lb dry}}{\text{hr}}$$

Run 3

$$0.9126 \times \frac{165.1 \text{ dsaf}}{\text{min}} = \frac{1519.7 \text{ lb day}}{\text{hr}}$$

Run 4

$$0.9126 \times \frac{1665.2 \text{ sec}}{\text{min}} = \frac{1519.726 \text{ day}}{\text{hr}}$$

Volume of Natural Gas Fired (cf)

	2	3	4
(CF)	10000	2000	2000
min)	182	177	142



Gilbert/Commonwealth engineers and consultants

LABORATORY SERVICES

30 NOBLE STREET, READING, PA 19611

GILBERT ASSOCIATES, INC., P. O. Box 1498, Reading, PA 19603/Tel. 215 775-2600

CERTIFICATE OF ANALYSIS

LABORATORY NO: 28967

RECEIVED: 5/14/84

REPORTED: 5/31/84

CLIENT: GCA Corp, 213 Burlington Rd.
Bedford, MA 01730

SAMPLE DESCRIPTION: Sludge Feed
36298-304 Composite
Grab
Sampled 5/9/84 by Mark McCabe/Joe Vitale

		AS RECEIVED	DRY BASIS
Total Moisture	%	77.7	
Ash	%	4.90	22.0
Heating Value	Btu/lb	1545	6929
Sulfur	% S	0.10	0.44
Carbon	% C	8.75	39.2
Hydrogen (excluding H in moisture)	% H	1.21	5.42
Hydrogen (including H in moisture)	% H	9.90	
Nitrogen	% N	0.35	1.58
Oxygen (excluding O in moisture)	% O	7.00	31.4
Oxygen (including O in moisture)	% O	76.0	

Respectfully submitted,

R. M. Large, Program Supervisor
Laboratory Services

MAH

cc: Mark McCabe (2)

APPENDIX D

FIELD DATA SHEETS AND
QUALITY ASSURANCE DATA

PARTICULATE / NONPARTICULATE FIELD DATA
CODING FORM
PG 1 of 2

SHEET 1 OF 3
PREPARED BY AW
PITOT NUMBER and SIDE _____
PITOT TUBE CP _____
FILTER No. / THIMBLE No. 1
AMBIENT TEMP. °F 37
BAR. PRESS., in. Hg 30.65
ASSUMED MOISTURE, % 10
HEATER BOX SETTING, °F 250
NOZZLE #/DIA., in. 022 1
PROBE LENGTH 5'
PROBE HEATER SETTING 250

VERY IMPORTANT - FILL IN ALL BLANKS

READ AND RECORD AT THE START OF EACH
TEST POINT SKETCH

CLIENT EPA
PROJECT No. _____
PLANT NB
RUN No. 2
LOCATION main stack
DATE 1 Feb 84
OPERATOR AW
SAMPLE BOX NO. 1720
METER BOX NO. _____
METER ΔH@ 1.913
Y FACTOR .997

* FIELDS FOR NONPARTICULATE RUN

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	21 RUN	31 DRY GAS METER, CF	41* PITOT in. H ₂ O ΔP	46 ORIFICE ΔH in. H ₂ O DESIRED	51 56 DRY GAS TEMP. °F INLET	OUTLET	PUMP VACUUM IN. Hg GAUGE	BOX TEMP °F	IMPINGER TEMP °F	61* STACK PRESS in. H ₂ O in. Hg	66* STACK TEMP °F °C	71* 75 NULL ANGLE (DEGREES)
1		10.7	0.0	500.245	.005	.76	.76	87	88	4	228	35	55	
2			4.0	502.2	.005	.76	.76	86	84	4	233	36	55	
3			8.0	504.1	.005	.76	.76	86	92	4	244	37	55	
4			12.0	506.0	.005	.76	.76	86	94	4	249	36	55	
5			16.0	507.8	.01	1.5	1.5	86	95	6	256	36	55	
6			20.0	510.4	.005	.76	.76	86	98	4	262	35	54	
7			24.0	512.5	.005	.76	.76	86	98	4	269	34	54	
8			28.0	514.4	.01	1.6	1.6	87	99	6	271	36	54	
9			32.0	517.5	.01	1.6	1.6	88	103	6	275	37	55	
10			36.0	520.5	.01	1.6	1.6	88	104	6	257	37	54	
11			40.0	522.6	.01	1.6	1.6	88	104	6	231	38	54	
TOTAL														

METER LEAK CHECK:

BEFORE TEST: .01 CF 60 SEC 15 in. Hg
AFTER TEST: _____ CF _____ SEC _____ in. Hg

PITOT LEAK CHECK _____

ORSAT LEAK CHECK _____

STATIC PRESSURE

PORT _____

in. H₂O _____

in. Hg _____

COMMENT

CLIENT EPAPARTICULATE/NONPARTICULATE FIELD DATA
CODING FORM
PG. 2 of 2SHEET 2 OF 3
PREPARED BY AW

PROJECT NO. _____

PLANT New Bedford

LOCATION _____

RUN NO. 2DATE 1 Feb 84

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT in. H ₂ O ΔP	ORIFICE ΔH in. H ₂ O DESIRED	ORIFICE ΔH in. H ₂ O ACTUAL	DRY GAS TEMP. °F INLET	DRY GAS TEMP. °F OUTLET	PUMP VACUUM IN. Hg GAUGE	BOX TEMP. °F	IMPINGER TEMP. °F	STACK PRESS in. H ₂ O in. Hg	STACK TEMP. °F °C	NULL ANGLE (DEGREES)
12			44.0	525.4	.01	1.6	1.6	89	105	6	256	39		53	
13			48.0	528.2	.01	1.6	1.6	89	105	6	267	39		54	
14			52.0	531.3	.01	1.6	1.6	89	106	6	271	40		54	
15			56.0	533.7	.01	1.6	1.6	90	106	6	228	39		54	
16			60.0	536.5	.01	1.6	1.6	89	106	6	251	40		53	
17			64.0	539.3	.01	1.6	1.6	90	106	6	267	38		53	
18			68.0	542.2	.01	1.6	1.6	90	106	6	275	38		53	
19			72.0	544.9	.01	1.6	1.6	90	106	6	232	37		53	
20			76.0	547.8	.005	.76	.76	90	106	4	252	38		53	
21			80.0	549.8	.005	.76	.76	90	105	4	264	37		53	
22			84.0	551.8	.005	.76	.76	91	104	4	262	38		52	
23			88.0	553.6	.005	.76	.76	91	103	4	272	38		52	
24			92.0	555.7	.005	.76	.76	91	103	4	225	39		52	
		242	96.0	557.53											
			STOP												
1	START	3:00	0.0	558.502	.005	.76	.76	91	95	4	246	30		52	
2			4.0	560.4	.005	.76	.76	90	96	4	255	30		52	
3			8.0	562.3	.005	.76	.76	91	98	4	262	31		52	
4			12.0	564.2	.005	.76	.76	91	99	4	269	30		52	
5			16.0	566.2	.005	.76	.76	94	100	4	275	30		52	
6			20.0	568.1	.005	.76	.76	91	100	4	230	30		52	
7			24.0	570.1	.005	.76	.76	91	101	4	226	30		52	
TOTAL															

METER LEAK CHECK DURING TEST: METER READING
STOP START.02 CF 60 SEC 10 in. Hg port change
.02 CF 60 SEC 10 in. Hg " "STATIC PRESSURE PORT _____
in. H₂O _____
in. Hg _____

COMMENTS:

Final
check96
96
192

DRS-5

(REVISED 8/31/79)

* FIELDS FOR NONPARTICULATE RUN

CLIENT EPAPARTICULATE/NONPARTICULATE FIELD DATA
CODING FORM
PG. 2 of 2SHEET 3 OF 3
PREPARED BY _____

PROJECT NO. _____

PLANT New Bedford Town WaterLOCATION MAIN STREETRUN NO. 2DATE 1 Feb 84

1*	5*	11*	21	31	41*	46	51	56	61*	66*	71*	75			
POINT	DISTANCE IN INCHES	CLOCK TIME		DRY GAS METER, CF	PITOT in. H ₂ O ΔP	ORIFICE ΔH in. H ₂ O		DRY GAS TEMP. °F		PUMP VACUUM IN. Hg GAUGE	BOX TEMP. °F	IMPINGER TEMP. °F	STACK PRESS in. H ₂ O in. Hg	STACK TEMP. °F °C	NULL ANGLE (DEGREES)
		ACTUAL	RUN			DESIRED	ACTUAL	INLET	OUTLET						
8			28	572.0	.005	.76	.76	91	101	4	240	29		52	
9			32	573.9	.005	.76	.76	91	101	4	261	29		52	
10			36	575.9	.005	.76	.76	91	102	4	266	28		53	
11			40	577.8	.005	.76	.76	91	102	4	275	28		52	
12			44	579.8	.005	.76	.76	91	102	4	225	27		53	
13			48	581.6	.005	.76	.76	91	102	4	245	28		53	
14			52	583.6	.005	.76	.76	91	102	4	265	28		53	
15			56	585.5	.005	.76	.76	91	102	4	277	28		53	
16			60	587.7	.005	.76	.76	91	101	4	237	25		53	
17			64	589.6	.005	.76	.76	91	102	4	236	28		53	
18			68	591.3	.005	.76	.76	91	102	4	271	28		53	
19			72	593.4	.005	.76	.76	91	102	4	224	28		53	
20			76	595.1	.005	.76	.76	92	103	4	246	28		53	
21			80	597.1	.005	.76	.76	92	103	4	272	28		53	
22			84	599.1	.005	.76	.76	92	103	4	235	28		53	
23			88	600.9	.005	.76	.76	92	103	4	247	28		53	
24			92	602.8	.005	.76	.76	92	103	4	274	28		53	
		4:36	96	603.549											
			STOP												
			END												
TOTAL															

METER LEAK CHECK DURING TEST:

METER READING
STOP START02 CF 60 SEC 8 in. Hg _____
_____ CF _____ SEC _____ in. Hg _____

STATIC PRESSURE

PORT

in. H₂O

in. Hg

COMMENTS:

$$A = \pi R^2$$

DRS-5

(REVISED 8/31/79)

* FIELDS FOR NONPARTICULATE RUN

GCA/TECHNOLOGY DIVISION
SOURCE PARTICULATE SAMPLING
TRAIN ASSEMBLY, RECOVERY AND ANALYTICAL REPORT SHEET

Run Date: 1 Feb 84 Client: EPA
Run No.: 2 W. O. No.: _____
Sample Box No.: 1726 Plant: New Bedford
Operator: AW Sampling Location: MAIN STACK

FRONT HALF

Laboratory Results

Nozzle and Probe (Cyclone Bypass)-Acetone Wash, Lab No.: 36233 Residue 5.3 mg
Cyclone and Flask-Acetone Wash Lab No.: _____ Residue _____ mg

Thimble No.	Lab No.	Weight Results
<u>NA</u>		_____ mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Thimble particulate weight NA mg

Filter No.	Lab No.	Weight Results
<u>GC-29</u>		<u>12.06</u> mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Filter particulate weight 12.06 mg

FRONT HALF Sub Total 17.36 mg

BACK HALF

Impinger WATER and Water Wash of Impingers
Connectors and Back Half of Filter Holder
Lab No.: _____

Collected on 0.22u Filter NA mg
Chloroform-ether Extract NA mg
Aqueous Residue NA mg

ACETONE WASH of
Impinger, Connectors and Back Half of
Filter Holder
Lab No.: _____

Residue 95.0 mg
BACK HALF Sub Total 95.0 mg

TOTAL TRAIN

TOTAL WEIGHT (Front & Back) 112.36 mg

MOISTURE

Impingers: 1 1/2 200 ml
415 200 ml
(Back half) 225

Silica Gel

Weight after test: 344.9
Weight before test: 329.4

Net Weight: 15.5
Container No.: 1. _____ 2. _____ 3. _____ 4. _____

Final Volume Total _____
Initial Volume Total 400 ml
Net Volume 415

TOTAL NET WEIGHT-Silica Gel _____ gm
NET VOLUME-Impingers _____ ml
TOTAL MOISTURE 30.5 gm

Comments: _____

LAB: DATE RECEIVED _____
DATE REPORTED 3/30/84 AW

Train Assembled by: AW + RV + m.m.
Sample Recovered by: " " "
Sample Analyzed by: _____

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36233WO No. 1-619-099Client EPQDate Received 3/8/84Description Front half Rinse
Acetone & Dioxane NB-45-FH-2

A. SAMPLE VOLUME

250 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>2-1</u>	<u>108.0619</u> g
<u>2-2</u>	<u>0.62462</u> g
	_____ g
	_____ g

CONTAINER NO.

2-1

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

RH/°F	Date/Time		RH/°F	Date/Time	
____/____	____/____	(1) <u>108.0687</u> g	____/____	____/____	(4) _____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 108.0687 gTotal Tare Weight 108.0619 gResidue Weight .0068 gBlank Weight .0015 g

+

.0053 g

Filter

0.63668- 0.62462.01206

E. NET WEIGHT

Remarks: _____

Analyst Rene Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36245WO No. 1-619-099Client EPADate Received 3/8/84Description Back half Rinse
Acetone & Hexane NB-M5-13H-2

A. SAMPLE VOLUME

250 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL \times _____ g/mL = _____ gm

+

Wash: _____ mL \times _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container 24-7 110.5479 g

Filter _____ g

Thimble _____ g

Total _____ g

CONTAINER NO.

24-7

0.22/0.45

 μ

FILTER NO.

E. GROSS WEIGHTS

RH/°F	Date/Time		RH/°F	Date/Time	
____/____	____/____	(1) <u>110.5579</u> g	____/____	____/____	(4) _____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 110.5579 gTotal Tare Weight 110.5479 gResidue Weight 0.0100 gBlank Weight 0.0050 g

↓

0.0950 g

E. NET WEIGHT

Remarks: _____

Analyst Rene Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36237WO No. 1-619-099Client EPADate Received 3/8/84Description front half Runse
Acetone & Nonyl NB-M5-FH-FBB-2

A. SAMPLE VOLUME

200 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>21-5</u>	<u>109.6200</u> g
	_____ g
	_____ g
	_____ g

CONTAINER NO.

21-5

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

RH/°F	Date/Time	(1)	RH/°F	Date/Time	(4)
____/____	____/____	_____ g	____/____	____/____	_____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 109.6209 gTotal Tare Weight 109.6200 gResidue Weight .0009 gBlank Weight _____ g

↓

.0009 g

E. NET WEIGHT

Remarks: _____

Analyst Ronnie Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36249WO No. 1-619-099Client EPADate Received 3/8/84Description Back half Runoff
Acetone & Hexane NB-45-BH-FBB2A. SAMPLE VOLUME75 mLB. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>21-11</u>	<u>106.7397</u> g
	_____ g
	_____ g
	_____ g

CONTAINER NO.

21-11

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

RH/°F

Date/Time

RH/°F

Date/Time

____/____	____/____	(1) <u>106.7414</u> g	____/____	____/____	(4) _____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 106.7414 gTotal Tare Weight - 106.7397 gResidue Weight .0017 g

Blank Weight - _____ g

↓

.0017 gE. NET WEIGHT

Remarks: _____

Analyst Renee Arrigo

GCA TECHNOLOGY DIVISION

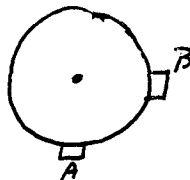
PARTICULATE / NONPARTICULATE FIELD DATA
CODING FORM
PG 1 of 2

SHEET 1 OF 3
 PREPARED BY AW
 PITOT NUMBER and SIDE _____
 PITOT TUBE CP _____
 FILTER No. / THIMBLE No. 1
 AMBIENT TEMP. °F 49
 BAR. PRESS., in. Hg 30.40 29.85
 ASSUMED MOISTURE, % 10 2
 HEATER BOX SETTING, °F 250
 NOZZLE #/DIA., in. .622 1
 PROBE LENGTH 5
 PROBE HEATER SETTING 250°

VERY IMPORTANT - FILL IN ALL BLANKS

READ AND RECORD AT THE START OF EACH
TEST POINT

SKETCH



* FIELDS FOR NONPARTICULATE RUN

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	21 RUN	31 DRY GAS METER, CF 607.576	41* PITOT in. H ₂ O ΔP	46 ORIFICE ΔH in. H ₂ O DESIRED	51 56 DRY GAS TEMP. °F INLET	56 OUTLET	PUMP VACUUM IN. Hg GAUGE	BOX TEMP °F	IMPINGER TEMP. °F	61* 66* STACK PRESS. in. H ₂ O in. Hg	71* 75 STACK TEMP. °F °C	NULL ANGLE (DEGREES)
1B	START	3:08	0.0	606.855	.005	.92	.92	73	71	5	235	36	50	
2			4.0	609.7	.005	.84	.84	73	72	4	244	37	51	
3			8.0	611.8	.005	.84	.84	73	75	4	263	38	51	
4			12.0	613.6	.005	.84	.84	73	79	4	274	38	51	
5			16.0	615.6	.005	.84	.84	74	82	4	262	38	51	
6			20.0	617.7	.005	.84	.84	75	85	4	224	38	51	
7			24.0	619.7	.005	.84	.84	76	87	4	242	38	51	
8			28.0	621.7	.005	.84	.84	77	90	4	269	39	51	
9			32.0	623.7	.005	.91	.91	78	92	4	272	39	51	
10			36.0	625.8	.005	.91	.91	79	93	4	261	38	51	
11			40.0	627.8	.005	.91	.91	81	95	4	245	39	50	
TOTAL														

METER LEAK CHECK:

BEFORE TEST: .02 CF 60 SEC 15 in. Hg

AFTER TEST: _____ CF _____ SEC _____ in. Hg

PITOT LEAK CHECK ✓

ORSAT LEAK CHECK _____

STATIC PRESSURE

PORT _____
 in. H₂O _____
 in. Hg _____

COMMENT

DRS-4

(REVISED 8/31/79) 42 36

44

CLIENT EPAPARTICULATE/NONPARTICULATE FIELD DATA
CODING FORM
PG. 2 of 2SHEET 2 OF 3PREPARED BY AW + J.V.

PROJECT NO. _____

PLANT N-BLOCATION MAN STACKRUN NO. 3DATE 6 Feb 81

1*	5*	11*	21	31	41*	46	51	56	61*	66*	71*	75			
POINT	DISTANCE IN INCHES	CLOCK TIME		DRY GAS METER, CF	PITOT in. H ₂ O ΔP	ORIFICE ΔH in. H ₂ O		DRY GAS TEMP. °F		PUMP VACUUM IN. Hg GAUGE	BOX TEMP. °F	IMPINGER TEMP. °F	STACK PRESS in. H ₂ O in. Hg	STACK TEMP. °F °C	NULL ANGLE (DEGREES)
		ACTUAL	RUN			DESIRED	ACTUAL	INLET	OUTLET						
12			44	629.1	.005	.91	.91	82	96	4	250	39		50	
13			48	632.1	.005	.91	.91	83	97	4	253	38		50	
14			52	634.2	.005	.91	.91	84	98	4	245	38		50	
15			56	636.3	.005	.91	.91	85	98	4	250	38		50	
16			60	638.4	.005	.91	.91	86	99	4	244	37		50	
17			64	640.6	.005	.91	.91	87	99	4	237	37		50	
18			68	642.6	.005	.91	.91	88	100	4	249	37		50	
19			72	644.7	.005	.91	.91	88	100	4	261	38		50	
20			76	646.7	.005	.91	.91	89	101	4	265	39		50	
21			80	648.9	.005	.91	.91	89	102	4	267	38		50	
22			84	651.0	.005	.91	.91	90	102	4	274	39		50	
23			88	653.0	.005	.91	.91	90	102	4	266	39		50	
24			92	655.1	.005	.91	.91	91	102	4	229	42		50	
			96	657.213											
X	STOP	4:44	STOP	PORT	CHANGE										
1	START	4:50	0.0	657.411	.005	.91	.91	91	98	4	272	46		50	
2			4.0	659.4	.005	.91	.91	92	100	4	270	46		50	
3			8.0	661.6	.005	.91	.91	92	102	4	275	45		50	
4			12.0	663.7	.005	.91	.91	92	103	5	246	44		50	
5			16.0	665.8	.005	.91	.91	93	104	5	207	42		50	
6			20.0	668	.005	.91	.91	93	104	5	231	41		50	
TOTAL															

METER LEAK CHECK DURING TEST: METER READING
STOP START.01 CF 60 SEC 8 in. Hg port change
_____ CF _____ SEC _____ in. Hg _____STATIC PRESSURE PORT _____
in. H₂O _____
in. Hg _____

COMMENTS:

* FIELDS FOR NONPARTICULATE RUN

DRS-5

(REVISED 8/31/79)

GCA/TECHNOLOGY DIVISION
SOURCE PARTICULATE SAMPLING
TRAIN ASSEMBLY, RECOVERY AND ANALYTICAL REPORT SHEET

Run Date: 6 Feb 84 Client: EPA
Run No.: 3 W. O. No.: _____
Sample Box No.: 1726 Plant: N.B. Incinerator
Operator: AW Sampling Location: MAIN STACK

FRONT HALF

Laboratory Results

Nozzle and Probe (Cyclone Bypass)-Acetone Wash,
Cyclone and Flask-Acetone Wash

Lab No.: 36246 Residue 11.5 mg
Lab No.: _____ Residue _____ mg

Thimble No.	Lab No.	Weight Results
<u>NA</u>		_____ mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Thimble particulate weight NA mg

Filter No.	Lab No.	Weight Results
<u>C-31</u>		<u>59.13</u> mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Filter particulate weight 59.13 mg

FRONT HALF Sub Total 70.63 mg

BACK HALF

Impinger WATER and Water Wash of Impingers
Connectors and Back Half of Filter Holder
Lab No.: _____

Collected on 0.22u Filter NA mg
Chloroform-ether Extract NA mg
Aqueous Residue NA mg

ACETONE WASH of
Impinger, Connectors and Back Half of
Filter Holder
36246
Lab No.: 36246

Residue 16.8 mg
BACK HALF Sub Total 16.8 mg

TOTAL TRAIN

TOTAL WEIGHT (Front & Back) 87.43 mg

MOISTURE

Impingers: 172 200 ml
445 300 ml
172+320.5 ml
45 195 ml

Silica Gel

Weight after test: 351
Weight before test: 337.1
Net Weight: 11.9
Container No.: 1. _____ 2. _____ 3. _____ 4. _____

Final Volume Total _____
Initial Volume Total _____
Net Volume 0.0

TOTAL NET WEIGHT-Silica Gel _____ gm
NET VOLUME-Impingers _____ ml
TOTAL MOISTURE 11.9 gm

Comments: _____

LAB: DATE RECEIVED _____
DATE REPORTED 3/20/84 MW

Train Assembled by: _____
Sample Recovered by: _____
Sample Analyzed by: _____

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36234 WO No. 1-619-099
 Client EPA Date Received 3/8/84

Description front half Bense
Acetone & Methylene NB-145-FH-3

A. SAMPLE VOLUME

250 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>4-2</u>	<u>105.8358 g</u>
<u>6-31</u>	<u>0.62703 g</u>
	_____ g
	_____ g

CONTAINER NO.

4-2

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

RH/°F	Date/Time	(1)	RH/°F	Date/Time	(4)
____/____	____/____	<u>105.8414 g</u>	____/____	____/____	_____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 105.8414 g

Total Tare Weight 105.8358 g

Residue Weight .0126 g

Blank Weight .0009 g

.0011

Filter

0.68616

0.62703

.05913 g

.0117 g

.0115

E. NET WEIGHT

Remarks:

Analyst

Rene Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36546 WO No. 1-619-099
 Client EPA Date Received 3/8/84

Description Back half Bunsen
Acetone & Hexane NB-M5-BH-3

A. SAMPLE VOLUME B. WASH VOLUME C. BLANK CORRECTION
200 mL _____ mL Sample: _____ mL \times _____ g/mL = _____ gm
 _____ mL _____ mL +
 _____ mL _____ mL Wash: _____ mL \times _____ g/mL = _____ gm
 _____ mL _____ mL =
 Total _____ mL TOTAL _____ gm

D. TARE WEIGHTS

	No.	Wt.
Container	<u>21-8109.2205</u>	
Filter	<u>GE 30</u>	<u>0.62703</u> g
Thimble		g
Total		g

CONTAINER NO.

21-8
 0.22/0.45
 μ
 FILTER NO.
E. GROSS WEIGHTS

<u>RH/OF</u>	<u>Date/Time</u>		<u>RH/OF</u>	<u>Date/Time</u>	
<u>/</u>	<u>/</u>	(1) <u>109.2418</u>	<u>/</u>	<u>/</u>	(4) _____ g
<u>/</u>	<u>/</u>	(2) _____ g	<u>/</u>	<u>/</u>	(5) _____ g
<u>/</u>	<u>/</u>	(3) _____ g	<u>/</u>	<u>/</u>	(6) _____ g

Final Gross Weight 109.2418 g
 Total Tare Weight 109.2205 g
 Residue Weight .0213 g
 Blank Weight .0045 g

Filter
0.68616
0.62703
-0.05913

+

.0163 gE. NET WEIGHT

Remarks:

Analyst

Renee Carriaga

GCA TECHNOLOGY DIVISION

PARTICULATE / NONPARTICULATE FIELD DATA
CODING FORM
PG 1 of 2

SHEET 1 OF 3
 PREPARED BY AW
 PITOT NUMBER and SIDE _____
 PITOT TUBE CP _____
 FILTER No. / THIMBLE No. 1
 AMBIENT TEMP. °F 30
 BAR. PRESS., in. Hg 29.86
 ASSUMED MOISTURE, % 2
 HEATER BOX SETTING, °F 250
 NOZZLE #/DIA., in. .622 1
 PROBE LENGTH 5 ft
 PROBE HEATER SETTING 250

CLIENT EPA
 PROJECT No. _____
 PLANT N.B. Incinerator
 RUN No. 4
 LOCATION main stack
 DATE 7 Feb 84
 OPERATOR AW + R.V.
 SAMPLE BOX NO. 1726
 METER BOX NO. _____
 METER ΔH@ 1.913
 Y FACTOR .997

VERY IMPORTANT - FILL IN ALL BLANKS

READ AND RECORD AT THE START OF EACH
 TEST POINT SKETCH

* FIELDS FOR NONPARTICULATE RUN

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	RUN	DRY GAS METER, CF	PITOT in. H ₂ O ΔP	ORIFICE ΔH in. H ₂ O DESIRED	ACTUAL	DRY GAS TEMP. °F INLET	OUTLET	PUMP VACUUM in. Hg GAUGE	BOX TEMP. °F	IMPINGER TEMP. °F	STACK PRESS in. H ₂ O in. Hg	STACK TEMP °F °C	NULL ANGLE (DEGREES)
1	START	10:19	6.0	708.599	.005	.82	.82	72	73	5	237	33		52	
2			4.0	710.5	.005	.82	.82	74	75	5	259	35		51	
3			8.0	712.5	.005	.82	.82	74	77	5	270	35		52	
4			12.0	714.5	.005	.82	.82	75	80	5	268	36		51	
5			16.0	716.5	.005	.82	.82	76	83	5	270	35		51	
6			20.	718.5	.005	.82	.82	76	85	5	268	35		51	
7			24.	720.6	.005	.82	.82	77	87	5	268	34		51	
8			28.	722.5	.005	.91	.91	78	89	5	267	35		51	
9			32.	724.6	.005	.91	.91	79	91	5	265	35		51	
10			36.	726.7	.005	.91	.91	81	93	5	259	36		51	
11			40.	728.8	.005	.91	.91	82	94	5	262	36		52	
TOTAL															

METER LEAK CHECK:

BEFORE TEST: .02 CF 60 SEC 15 in. Hg
 AFTER TEST: _____ CF _____ SEC _____ in. Hg

PITOT LEAK CHECK ☒
 ORSAT LEAK CHECK _____

STATIC PRESSURE

PORT .0025
 in. H₂O _____
 in. Hg _____

COMMENT

10:19
 11:19
 36
 45

ORS-4

(REVISED 8/31/79)

CLIENT EPAPARTICULATE/NONPARTICULATE FIELD DATA
CODING FORM
PG. 2 of 2SHEET 2 OF 3PREPARED BY Am + JV

PROJECT NO. _____

PLANT N.B.LOCATION MAIN STACKRUN NO. 4DATE 7 Feb 84

1 *	5 *	11 *	21	31	41 *	46	51	56	61 *	66 *	71 *	75			
POINT	DISTANCE IN INCHES	CLOCK TIME		DRY GAS METER, CF	PITOT in. H ₂ O ΔP	ORIFICE ΔH in. H ₂ O		DRY GAS TEMP. °F		PUMP VACUUM IN. Hg GAUGE	BOX TEMP. °F	IMPINGER TEMP. °F	STACK PRESS in. H ₂ O in. Hg	STACK TEMP. °F °C	NULL ANGLE (DEGREES)
		ACTUAL	RUN			DESIRED	ACTUAL	INLET	OUTLET						
12			44	730.9	.005	.91	.91	83	95	5	269	35		52	
13			48	739.2	.005	.91	.91	83	95	5	272	37		51	
14			52	735.2	.005	.91	.91	84	96	5	262	37		51	
15			56	737.2	.005	.91	.91	84	95	5	264	35		50	
16			60	739.3	.005	.91	.91	85	96	5	272	36		50	
17			64	741.4	.005	.91	.91	86	97	5	275	37		50	
18			68	743.5	.005	.91	.91	87	98	5	239	38		50	
19			72	745.7	.0075	1.35	1.35	87	98	5	246	37		50	
20			76	749.2	.005	.91	.91	87	99	6	260	37		50	
21			80	750.4	.005	.91	.91	88	99	5	272	37		49	
22			84	752.5	.005	.91	.91	88	99	5	241	36		46	
23			88	754.6	.005	.91	.91	88	98	5	227	35		45	
24			92	756.7	.005	.91	.91	88	98	5	246	36		45	
			96	758.815											
		11:45	STOP	PORT	CHANGE										
1		12:00 START	0.0	759.191	.005	.91	.91	87	90	5	239	33		49	
2			4.0	761.5	.005	.91	.91	87	93	5	222	33		49	
3			8.0	763.7	.005	.91	.91	87	95	5	240	33		49	
4			12.0	765.7	.006	1.1	1.1	87	96	5	239	33		50	
5			16.0	767.8	.005	.91	.91	87	97	5	242	33		49	
6			20.	770.0	.005	.91	.91	87	97	5	248	33		50	
7			24.	772.1	.005	.91	.91	87	97	5	260	32		50	
TOTAL															

METER LEAK CHECK DURING TEST:

METER READING
STOP START

.01 CF 60 SEC 7 in. Hg

.01 CF 60 SEC 7 in. Hg

→ Port Change

STATIC PRESSURE

PORT

in. H₂O

in. Hg

COMMENTS:

* FIELDS FOR NONPARTICULATE RUN

DRS-5

(REVISED 8/31/79)

GCA/TECHNOLOGY DIVISION
SOURCE PARTICULATE SAMPLING
TRAIN ASSEMBLY, RECOVERY AND ANALYTICAL REPORT SHEET

Run Date: 7 Feb 84 Client: EPA
Run No.: 4 W. O. No.: _____
Sample Box No.: 1726 Plant: N.B. Instruments
Operator: AW + RV Sampling Location: MAIN STACK

FRONT HALF

Laboratory Results

Nozzle and Probe (Cyclone Bypass)-Acetone Wash, Lab No.: 36235 Residue 7.7 mg
Cyclone and Flask-Acetone Wash Lab No.: _____ Residue _____ mg

Thimble No.	Lab No.	Weight Results
<u>NA</u>		_____ mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Thimble particulate weight NA mg

Filter No.	Lab No.	Weight Results
<u>FE-32</u>		<u>117.04</u> mg
_____		_____ mg
_____		_____ mg
_____		_____ mg

Filter particulate weight 117.04 mg

FRONT HALF Sub Total 124.74 mg

BACK HALF

Impinger WATER and Water Wash of Impingers
Connectors and Back Half of Filter Holder
Lab No.: _____

Collected on 0.22u Filter NA mg
Chloroform-ether Extract NA mg
Aqueous Residue NA mg

ACETONE WASH of
Impinger, Connectors and Back Half of
Filter Holder
Lab No.: _____

Residue 51.8 mg
BACK HALF Sub Total 51.8 mg

TOTAL TRAIN

TOTAL WEIGHT (Front & Back) 176.54 mg

MOISTURE

Impingers: 12200
445200
1213 205.29
445 195760 mg

Silica Gel
Weight after test: 354.1
Weight before test: 324.1
Net Weight: 30.0
Container No.: 1. _____ 2. _____ 3. _____ 4. _____

Final Volume Total _____
Initial Volume Total _____
Net Volume 0.0

TOTAL NET WEIGHT-Silica Gel _____ gm
NET VOLUME-Impingers 0 ml
TOTAL MOISTURE 30.0 gm

Comments: _____

LAB: DATE RECEIVED _____
DATE REPORTED MW 3/20/84

Train Assembled by: _____
Sample Recovered by: _____
Sample Analyzed by: _____

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36235 WO No. 1-619-099
 Client EPA Date Received 3/8/89

Description front half Binse
Acetone & Nephene NB-M5-EH-4

A. SAMPLE VOLUME

250 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>2</u>	<u>108.1240</u> g
<u>GE 32</u>	<u>0.62372</u> g
	_____ g
	_____ g

CONTAINER NO.

2-3

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

RH/OF	Date/Time		RH/OF	Date/Time	
____/____/____	____/____/____	(1) <u>108.1328</u>	____/____/____	____/____/____	(4) _____ g
____/____/____	____/____/____	(2) _____ g	____/____/____	____/____/____	(5) _____ g
____/____/____	____/____/____	(3) _____ g	____/____/____	____/____/____	(6) _____ g

Final Gross Weight 108.1328 g

Total Tare Weight 108.1240 g

Residue Weight 0.0088 g

Blank Weight 0.0009 g

+ 0.0011

0.0079 g

0.0077

Filter

0.74076

0.62372

0.11704

E. NET WEIGHT

Remarks: _____

Analyst

Renee Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSIS

Lab No. 36247 WO No. 1-619-099Client EPA Date Received 3/5/89Description Back Half Rinse
Acetone & Hexane NB-45-BH-4

A. SAMPLE VOLUME

200 mL

B. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL \times _____ g/mL = _____ gm

+

Wash: _____ mL \times _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>4-910379028</u>	_____ g
_____	_____ g
_____	_____ g
_____	_____ g

CONTAINER NO.

4-9

0.22/0.45

 μ

FILTER NO.

E. GROSS WEIGHTS

RH/OF	Date/Time	(1)	RH/OF	Date/Time	(4)
<u>/</u>	<u>/</u>	<u>103.8465</u>	<u>/</u>	<u>/</u>	_____ g
<u>/</u>	<u>/</u>	(2) _____ g	<u>/</u>	<u>/</u>	(5) _____ g
<u>/</u>	<u>/</u>	(3) _____ g	<u>/</u>	<u>/</u>	(6) _____ g

Final Gross Weight 103.8465 gTotal Tare Weight 103.7902 gResidue Weight .0563 gBlank Weight .0045 g

+

.0518 g

E. NET WEIGHT

Remarks: _____

Analyst Renee Arrigo

GCA/TECHNOLOGY DIVISION

PARTICULATE ANALYSISLab No. 36238WO No. 1-619-099Client EPADate Received 3/8/84Description Acetone & Hexane BlankUB-M5-FH-BA. SAMPLE VOLUME150 mLB. WASH VOLUME

_____ mL

_____ mL

_____ mL

_____ mL

Total _____ mL

C. BLANK CORRECTION

Sample: _____ mL × _____ g/mL = _____ gm

+

Wash: _____ mL × _____ g/mL = _____ gm

=

TOTAL _____ gm

D. TARE WEIGHTS

Container

Filter

Thimble

Total

No.	Wt.
<u>21-6108.6318</u>	<u>g</u>
_____	_____ g
_____	_____ g
_____	_____ g

CONTAINER NO.

21-6

0.22/0.45

μ

FILTER NO.

E. GROSS WEIGHTS

<u>RH/OF</u>	<u>Date/Time</u>		<u>RH/OF</u>	<u>Date/Time</u>	
____/____	____/____	(1) <u>108.6318</u> g	____/____	____/____	(4) _____ g
____/____	____/____	(2) _____ g	____/____	____/____	(5) _____ g
____/____	____/____	(3) _____ g	____/____	____/____	(6) _____ g

Final Gross Weight 108.6318 gTotal Tare Weight 108.6299 gResidue Weight .0019 g

Blank Weight _____ g

↓

.0019 gE. NET WEIGHT

Remarks: _____

Analyst

Roxie Arrigo

The purpose of this form is to document prior approval from the Analytical Laboratory representative that the reagents, materials and procedures used in sample collection tasks are compatible with subsequent laboratory analysis requirements.

Field Team Leader: M. McCABESampling Task: PCB TESTContract Number: 1-619-099Anticipated Sampling Date 1/23/84Site Identification NEW BEDFORD MC/M

Field Sample Code	Sample Description	Container	Preservative	Reagent/Grade (Manufacturer and Lot Number)	Laboratory Comment
VB MS - PF	PARTICULATE FILTER	GLASS	—	Roll Anal 934AH	
- FH	PARTICULATE RINSE	AMBER	—	ACETONE 316106	
- RH	IMPINGER RINSE	AMBER	—	HEXANE 341097	
- CD-O	ORGANIC COND	AMBER	—	ACETONE, HEXANE 341097	RINSE OF 1191 123
- FL	FLORISIL	GLASS	—	LOT# 30/60 MESH	IMP 1,23 catch
- XR	XAD-2	GLASS	—	LOT# 701	Cleaned up by R. P. Billard
- CD-I	INORG. COND	LPE	—		10% ALIQUOT of - CD-O
- IMP	IMPINGER CATCH	LPE	—	1N. NaOH	Fisher 6733825-X1
- PFB	PART FILT. BLANK	GLASS	—		IMP 4.5 catch
- FHB	PART RINSE BLANK	AMBER	—	ACETONE 316106	
- CD-OB	CONDENSATE BLANK	AMBER	—	HEXANE 341097	
- FL B	FLORISIL BLANK	GLASS	—	WATER PROVIDED BY LAB	
- XRB	XAD-2 BLANK	GLASS	—	LOT# 30/60 MESH	Cleaned up by R. P. Billard
			—	LOT# 701	

Submitted by Michael H. HulseDate 1/12/84Page 1 of 3

Follow-up Dates _____

Final Laboratory Approval _____

Date _____

GCA/Te
Div.
2/80

The purpose of this form is to document prior approval from the Analytical Laboratory representative that the reagents, materials and procedures used in sample collection tasks are compatible with subsequent laboratory analysis requirements.

Field Team Leader: M. McCABE
 Sampling Task: PCB TEST
 Contract Number: 1-619-099

Anticipated Sampling Date 1/23/84
 Site Identification NGW BEDFORD, NCIN

Field Sample Code	Sample Description	Container	Preservative	Reagent/Grade (Manufacturer and Lot Number)	Laboratory Comment
NB-MS-CD-TB	INDRG. CONDENSATE	LPE		WATER PROVIDED BY LAB	
-IMP-B	IMPINGED CATCH	LPE		IN NaOH	Fisher lot 733825
	PART. FILTER	Glass			exp. 7/85
ND-MS-IF-FBB	FIELD BIASED BLANK	Petri			
	PART. CATCH	Glass		KEPTONG 316106	
-FH-FBB	FIELD BIASED BLANK			HEXANE lot 341097	lot 334134 Acetone Being QC'd
	ORGANIC COND				
-CD-0-FBB	FIELD BIASED BLANK	Glass		WATER PROVIDED BY LAB	
	FLORISIL				
-FL-FBB	FIELD BIASED BLANK	Glass		LOT 30/60 MESH	Cleaned up by R. B. Miller
	XAD-2				
-XR-FBB	FIELD BIASED BLANK	Glass		LOT QC 701	
	INDRG. COND				
-CD-F-FBB	FIELD BIASED BLANK	Glass		WATER PROVIDED BY LAB	
	IMPINGED CATCH				
-IMP-FBB	FIELD BIASED BLANK	LPE		IN. NaOH	Fisher lot 733825
	IMPINGED CATCH			ACETONE 316106	
-BH-FBB	FIELD BIASED BLANK	Glass		HEXANE 341097	as above

Submitted by [Signature]

Date 1/19

Page 1 of 3

cc: M. White ✓
 R. M. Ellersick
 J. Ferragut

Follow-up Dates 1/19/84

Final Laboratory Approval [Signature]

Date 1/19/84

GCA/Tec
 Div.
 2/80

Field/Laboratory Procedure Coordination

The purpose of this form is to document prior approval from the Analytical Laboratory representative that the reagents, materials and procedures used in sample collection tasks are compatible with subsequent laboratory analysis requirements.

Field Team Leader: M. McCABE

Sampling Task: PCR TEST

Contract Number: 1-619-099

Anticipated Sampling Date 1/23/84

Site Identification NEW BEDFORD INCIN.

Field Sample Code	Sample Description	Container	Preservative	Reagent/Grade (Manufacturer and Lot Number)	Laboratory Comment
NB-PI	PLANT INFILTRANT (RAW SEWAGE)	AMBER	—	1a 2 c-d 500ml	
-SF	SLUDGE FEED	AMBER	—	1a → 5 500ml	
-SWP	SCRUBBER WATER	AMBER	—	2a → 5 1g amber	
-SE	FEED (POTABLE)	AMBER	—	2a → 5 1g amber	
-HA	SCRUBBER	AMBER	—	1a b c 500ml	
-CW	EFFLUENT	AMBER	—	2a → 5 1g amber BMT	
	WATER	AMBER	—		

Submitted by [Signature]

Date 1/18/84

Page 3 of 7

Follow-up Dates _____

Final Laboratory Approval _____

Date _____

GCA/Te
Div.
2/80

PRETEST NOZZLE CALIBRATION

Date 1/26/84 Set No. 92-SASS Calibrated by J. Lachner

Nozzl. identification number	D ₁ mm, (in.)	D ₂ mm, (in.)	D ₃ mm, (in.)	Δ D, mm, (in.)	D _{avg}
1-S	.374	.375	.375	.003	.374
2-S	.500	.499	.499	.001	.499
3-S	.623	.622	.622	.001	.622
5-1	.737	.737	.737	.000	.737
5-2	.868	.870	.871	.003	.870

POST-TEST NOZZLE CALIBRATION

Date _____ Set No. _____ Calibrated by _____

where:

D_{1,2,3} = nozzle diameter measured on a different diameter, mm (in.).
Tolerance = measure within 0.25 mm (0.001 in.).

Δ D = maximum difference in any two measurements, mm (in.).
Tolerance = 0.1 mm (0.004 in.).

D_{avg} = average of D₁, D₂, D₃.

Calibrated By J. Biberau / R. FlatleyBarometric Pressure, $P_b = 30.17$ in. HgDate 8 Nov 1983

Dry Gas Meter No. _____

Control Box No. 1726-9

Orifice manometer setting, ΔH , in. H ₂ O	Gas volume wet test meter V_w , ft ³	Gas volume dry gas meter V_d , ft ³	Temperature				Time 0, min	γ	ΔH_0	Deviation	
			Wet test	Dry gas meter							
			Meter t_w , °F	Inlet t_{di} , °F	Outlet t_{do} , °F	Average t_d , °F				γ	ΔH_0
0.5	5	5.084	77.0	77.0	77.0	77.5	15.07	.999	1.905		
1.0	5	5.095	77.0	77.0	77.0	77.0	15.14	.992	1.946		
2.0	10	10.234	77.0	77.0	77.0	77.75	13.19	.999	1.892		
Average								.997	1.913		

Calculations

γ	ΔH_0
$\frac{V_w P_b (t_d + 460)}{P_b (t_d + 460) \left(\frac{\Delta H}{11.6} \right) (t_w + 460)}$	$\frac{0.0317 \Delta H}{P_b (t_d + 460) \left[\frac{(t_w + 460) \theta}{V_w} \right]^2}$

Accuracy of accuracy of wet test meter to dry test meter. Tolerance = ± 0.01 Orifice pressure differential that gives 0.75 cfm of air at 70° F and 29.92 inches of mercury, in. H₂O. Tolerance = ± 0.15

Maintenance Checklist

Oil Reservoir Level ☒; Knockout Jar ☒Vacuum Gage ☒; Leak Chk (No Leak) 15" Hg ☒Connects: Clean ☒ Lubricate ☒Check for Leaks ☒; Fluid Level ☒; Clean Surface ☒Valve: Check for Click ☒2.5 amp. Probe Heater ☒; 7 amp. Pump ☒; 10 amp. Heater ☒Connector ☒ (Check with umbilical cord connected to hot box)~~Transformer~~ (Check operation with Probe or light)

(All Items Must Be Checked and Initialed)



Technology Division

QC Okayed

Calibrated By R Farley/R VachonBarometric Pressure, Pb = 29.23 in. HgDate 21 March 1984

Dry Gas Meter No. _____

Control Box No. 1726

Orifice manometer setting, ΔH , in. H ₂ O	Gas volume wet test meter V_w , ft ³	Gas volume dry gas meter V_d , ft ³	Temperature				Time t_o , min	γ	ΔH_0	Deviation γ ΔH_0	
			Wet test	Dry gas meter							
			Meter t_w , °F	Inlet t_{di} , °F	Outlet t_{do} , °F	Average t_d , °F					
0.5	5	5.078	62.5	68.5	71.5	70	13:11	.997	1.888		
1.0	5	5.1	62.5	71.5	73.5	72.5	9:26	.997	1.875		
2.0	10	10.232	62.5	72	78	75	13:18	.996	1.890		
Average								.997	1.884		

Calculations

γ	ΔH_0
$\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6} \right) (t_w + 460)}$	$\frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \theta}{V_w} \right]^2$

 γ = Ratio of accuracy of wet test meter to dry test meter. Tolerance = ± 0.01 ΔH_0 = Orifice pressure differential that gives 0.75 cfm of air at 70° F and 29.92 inches of mercury, in. H₂O. Tolerance = ± 0.15

Maintenance Checklist

Vacuum System: Oil Reservoir Level ☒; Knockout Jar ☒
 Vacuum Gage ☒; Leak Chk (No Leak) 15" Hg ☒
 Quick Connects: Clean ☒ Lubricate ☒
 Manometer: Check for Leaks ☒; Fluid Level ☒; Clean Surface ☒
 Solenoid Valve: Check for Click ☒
 Fuses: 2.5 amp. Probe Heater ☒; 7 amp. Pump ☒; 10 amp. Heater ☒
 Amphenol Connector ☒ (Check with umbilical cord connected to hot box)
~~Variable XFormer ☒ (Check Operation with Probe or Light)~~

(All Items Must Be Checked and Initialed)

GCA CORPORATION
Technology Division

QC Okayed _____

①

NB-MS

CHAIN OF CUSTODY RECORD WATER & WASTEWATER

[illegible]

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WE-5A

